PROCEEDINGS OF THE

Nineteenth Annual Convention

OF THE

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION

Successor to the

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS

HELD AT

JACKSONVILLE, FLORIDA

OCTOBER 19-21, 1909

AMERICAN RAILWAY BRIDGE AND BUILDING ASSN.

Official Badge

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1910

S. H. Patterson

Secretary 1892-1909

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Lehigh Valley Railroad.

J. H. Cummin .... Bay Shore, N. Y.

Aaron S. Markley .... Danville, Ill.
Chicago & Eastern Illinois Railroad.

Walter A. Rogers .... 355 Dearborn St., Chicago, Ill.

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R. H. Reid .... Cleveland, Ohio
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J. P. Canty .... Fitchburg, Mass.
Boston & Maine Railroad.

*Deceased.

COMMITTEES FOR 1909-10

I. Method of Protection to Embankments against currents and of restoring same when washed out.

E. L. Loftin, Q. & C. Ry., Vicksburg, Miss.
O. T. Nelson, A. & W. R. Ry., Montgomery, Ala.
J. M. Bibb, L. & N. R. R., Birmingham, Ala.
P. W. Cahill, S. A. L. Ry., Fernandina, Fla.
C. A. Thanheiser, T. & N. O. R. R., Houston, Tex.
E. K. Barrett, F. E. C. Ry., St. Augustine, Fla.

II. How to prevent Iron Pipe Culverts from pulling apart in soft ground, and how best to repair them when pulled apart.

A. A. Page, B. & M. R. R., Wilmington, Mass.
W. H. Moore, N. Y. N. H. & H. R. R., New Haven, Conn.
R. O. Elliott, L. & N. R. R., Columbia, Tenn.
H. C. Thompson, N. Y. C. & H. R. R. R., Weehawken, N. J.
F. C. Rand, B. & M. R. R., Boston, Mass.
J. S. Browne, N. Y. N. H. & H. R. R., Providence, R. I.

III. Concrete in Railroad Construction; kind of reinforcement and waterproofing when necessary.

C. W. Richey, P. R. R., Pittsburg, Pa.
W. M. Clark, B. & O. R. R., Glenwood, Pa.
G. H. Soles, P. & L. E. R. R., Pittsburg, Pa.
Stanton Bowers, P. C. C. & St. L. Ry., Bradford, Pa.
W. H. Finley, C. & N. W. Ry., Chicago.
T. L. D. Hadwen, C. M. & St. P. Ry., Chicago.
W. A. Rogers, 355 Dearborn St., Chicago.

IV. Arrangement of Buildings and Platforms, for small towns, as to convenience and appearance.

C. H. Fake, M. R. & B. T. R. R., Bonne Terre, Mo.
N. H. Lafountain, C. M. & St. P. Ry., Chicago.
A. W. Merrick, C. & N. W. Ry., Boone, Ia.
J. S. Berry, St. L. S. W. Ry., Tyler, Tex.
R. C. Young, L. S. & I. Ry., Marquette, Mich.
F. D. Beal, Supt. Pac. Creosoting Co., Seattle, Wash.

V. Best method of Determining Proper Dimensions of Openings for Waterways.

W. T. Main, C. & N. W. Ry., Chicago.
Hans Bentele, Nat. Rys. of Mex., Mexico City.
Onward Bates, 355 Dearborn St., Chicago.
J. S. Robinson, C. & N. W. Ry., Chicago.

VI. Best method of obtaining Elevation on Curves on Bridges and Trestles.

J. P. Snow, B. & M. R. R., Boston.
W. F. Steffens, B. & A. R. R., Boston.
A. Finley, G. T. Ry., Montreal.
D. G. Musser, Pa. Lines, Wellsville, O.
M. Burpee, B. & A. R. R., Houlton, Me.
F. L. Burrell, C. & N. W. Ry., Fremont, Neb.

VII. Best method of Numbering Bridges.

I. F. Stern, C. & N. W. Ry., Chicago.
E. B. Ashby, L. V. R. R., New York City.
Wm. Graham, N. Y. N. H. & H. R. R., New Haven, Conn.
W. H. Wilkinson, Erie R. R., Elmira, N. Y.
C. N. Monsarrat, C. P. Ry., Montreal.
R. H. Reid, L. S. & M. S. Ry., Cleveland, O.

VIII. The Economy and Practicability of Wire Glass in Roundhouses, Shops, and Station Buildings.

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C. F. Spencer, L. I. R. R., Jamaica, N. Y.
W. F. Strouse, B. & O. R. R., Baltimore, Md.
G. W. Andrews, B. & O. R. R., Baltimore, Md.
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A. Anderson, L. S. & I. Ry., Marquette, Mich.

IX. The Best Style and Dimensions of Hoops for Water Tanks of 50,000 to 100,000 Gallons Capacity.

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J. B. White, C. & N. W. Ry., Boone, Ia
John Ewart, B. & M. R. R., Boston, Mass.
Jas. Dupree, Sou. Ind. Ry., Crete, Ill.

X. Plans of Fireproof Oil Houses for storing large quantities of oil at principal terminal stations.

G. W. Rear, Sou. Pac. Co., San Francisco.
D. Robertson, Sou. Pac. Co., West Oakland, Cal.
F. Ingalls, N. P. Ry., Jamestown, N. D.
E. R. Floren, C. R. I. & P. Ry., Fairbury, Neb.

NOMINATIONS.

R. H. Reid, L. S. & M. S. Ry., Cleveland, O.
S. F. Patterson, B. & M. R. R., Concord, N. H.
A. S. Markley, C. & E. I. R. R., Danville, Ill.
W. O. Eggleston, Erie R. R., Huntington, Ind.
W. W. Perry, P. & R. Ry., Williamsport, Pa.

PUBLICATIONS.

A. Montzheimer, E. J. & E. Ry., Joliet, Ill.
J. B. Sheldon, N. Y. N. H. & H. R. R., Providence, R. I.
W. T. Main, C. & N. W. Ry., Chicago.

RELIEF.

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Proceedings of the Nineteenth Annual Convention

OF THE

American Railway Bridge and Building Association

HELD IN JACKSONVILLE, FLA., OCTOBER 19, 20 AND 21, 1909

MORNING SESSION.

The nineteenth annual convention was called to order at 10:30 o'clock A. M., by President J. P. Canty in the auditorium of the Windsor Hotel, Jacksonville, Florida, Tuesday, October 19, 1909.

President.—I will ask all present to arise while Brother B. F. Pickering leads us in prayer.

Prayer was then offered by Mr. Pickering.

President.—We are fortunate in having with us this morning, to address the association and extend a welcome to Jacksonville, Mr. W. S. Jordan, the mayor of this beautiful city.

Mayor Jordan then proceeded in an able and well chosen talk to extend on behalf of himself and fellow citizens of Jacksonville all of the courtesies which would naturally suggest themselves to people whose true southern hospitality had already been manifested by the elaborate plans set under way for the entertainment of our members and their families during the convention.

Mr. H. H. Richardson, secretary of the Jacksonville Board of Trade, then gave the association the pleasure of his attendance and in a happy and interesting address supplemented the welcome given us by the mayor, as follows:

Mr. President, ladies and members of the American Railway Bridge and Building Association: In the absence of our presi-

dent and vice-presidents it has devolved upon me, as secretary of the Jacksonville board of trade, to tender you a hearty welcome to our sunny Southland. I may say that I feel perfectly at home in the presence of these representatives of transportation companies, from the fact that for fifteen years of my residence in this city I was in the service of railroad corporations, in various capacities, and it may be interesting at this point to give a little experience of the pioneer days in the transportation business in Florida.

In the early eighties I was connected with the Orange Belt Ry., at that time probably the longest narrow-gage railroad in the United States. I came in with the new management, which ultimately made it a very model piece of railroad. Just previous to that time this railroad was owned and operated by a Russian, who was president, vice-president, secretary, treasurer and general manager rolled into one. The private car of this Pooh-Bah was an old caboose belonging to another road in the state, and was attached to a very ancient looking locomotive of the saddleback type which we still see occasionally in the logging camps. On one occasion this Russian was making a tour of his road on this private and very special train, and they had a break-down, and, try the best he could, the engineer could not get it to move. There were no telegraph facilities, and the general manager tore his hair and in his broken English wailed: "Vat shall ve do; vat shall ve do?" The engineer being somewhat of a joker folded his arms and calmly said: "Well, sir, the best thing we can do is to jack up the whistle and build a new engine underneath it." This made the manager, if possible, hotter than ever, and he roared: "Man you must not speak that vay to the Orange Belt Railroad. I am the Orange Belt Railroad. You are fired." As they were miles away from anywhere you can imagine this did not improve the situation very much. This is but one of many curious experiences in pioneer railroading.

Our organization took great pleasure in co-operating with the local committee of your members and the Lumbermen's Ass'n., in arranging a program for your entertainment which we hope will meet with your entire approval. It may not be inopportune at this time to tell you something of our progressive city, and to give you a vivid idea of its progress, it becomes necessary for me to go back to a very hot day in May, a few short years ago, when this city was visited with one of the most disastrous conflagations of the time. In eight hours there were destroyed upwards of 3,000 buildings, covering an area of 655 acres, and involving a loss of $15,000,000, with only $5,000,000 insurance. Ten thousand of our people were homeless that night, but with true cosmopolitan grit they did not sink in despair in the ashes of our city, for in a few days temporary buildings and shacks sprung up here and everywhere and business was resumed. At that time the population was only 28,000, of which 55 per cent were colored.

In the eight years of reconstruction since that time there have been expended upwards of $25,000,000, the population has increased 120 per cent, and we today have a population of 66,500 people. What appeared at the time to be a terrible disaster, like the experience of many other cities in this great land, has turned out to be a blessing in disguise, for today we have a modern, up-

to-date and beautiful city. It has more wholesale houses than any city of its size in the United States; it is the metropolis of Florida and the gateway to the land of Ponce de Leon.

One of the great pieces of work undertaken by the board of trade to upbuild our commerce has been the deepening of our waterways. Twenty years ago the channel from the city to the sea was only eleven feet in depth, and, like the Irishman's flea, was jumping from one side of the river to the other. To show faith in our work our county bonded itself for $300,000, to make the first improvements, and by the persistent and tireless efforts of our waterway committee, with the aid of the national congress, we now have a channel 24 feet in depth at low tide, and a further bond is being made at this time to increase the depth to 30 feet at low tide. Every foot of depth added to this channel has shown a marked increase in the commerce of the city, and the development of Jacksonville as a port has increased the business of the railroad transportation companies beyond measure.

We hope that while in the city you will find the opportunity to visit some of our industrial enterprises and factories, our products consisting largely of lumber, turpentine, naval stores, cigars and many other articles. Florida today produces 50 per cent of the naval stores, rosin and turpentine consumed in the world.

One of the interesting sights that you will see while here is our famous ostrich farm, which is not merely a place of amusement, but actually a paying investment, from a commercial standpoint. Both the ladies and gentlemen will be interested in this sight, the ladies from the fact that they will see from whence comes their beautiful ostrich plumes and feather boas. I hope the gentlemen will take with them their fat pocket books, for I feel sure that when they come away they will be flat instead of fat.

Your trip down the majestic St. John's river tonight will be a revelation to you. Possibly you are not aware that this beautiful stream is one of the very few in the country which, for a distance of several hundred miles, flows in a northerly direction. Its banks are the scenes of interesting historical happenings, from the time of Ponce de Leon and De Soto, and the scenes of the massacres by the Indians of the original white settlers 400 years ago. Florida has indeed a most romantic history, having existed under four flags, Spain, France, England and the United States, and while we probably have not as many ancient things to show you as the City of Boston, yet, as I told the Boston people a few months ago, we can show them historical remains that antedate even some of their pleasing sights.

For Wednesday evening we have arranged, in accordance with the program, what is called a "Dutch lunch." Why it was so-called I cannot understand, unless it was named by the chairman of your local committee, Mr. Cahill, who is an Irishman. However, we have done the best we can to live up to the name, and we feel sure that you will have a pleasant evening with us in our board of trade auditorium that night.

One of the most interesting features, probably, of your trip to this city would have been the trip on the wonderful "Over-the-Sea" railway extension to Key West, the development of which is largely due to those captains of industry. Mr. Henry M. Flagler and the late Henry B. Plant. The construction of a concrete viaduct

from the mainland of Florida to Key West is one of the most stupendous undertakings of the century. I was over the work in March and was astonished to find the magnitude of it. It is Mr. Flagler's aim to get this road completed and trains running on it by his birthday, in January, 1910. It is with extreme regret that I learn today that owing to the damage done by the recent violent hurricane it will be impossible for your party to visit this work, as I am sure it will be a great disappointment to you. I desire to point out to you that it is not considered that there will be any danger of this structure being damaged similarly after its completion, as the damage that was done was only to the uncompleted approaches of these long concrete viaducts.

I notice on my right a large majority of the male members of this organization, and on my left a majority of the ladies. I presume that the male members on my right could properly be described as bridge workers and the ladies on my left as bridge players. (Laughter.)

And now, ladies and gentlemen, I again bid you welcome to our city and our state, the land of sunshine, the land of the orange blossom and its golden fruit, the land where the mocking bird sings you to sleep at night and awakens you in the morning with its beautiful song; and, for the benefit of the youthful ladies and gentlemen who are here, I may say also, the land where Ponce de Leon sought for and found the fountain of perpetual youth; and I feel that all of you will take advantage of your opportunities and get some of the Florida sand in your shoes, when I predict that many of you will again visit our beautiful sunny southland. Mr. President and friends, I wish, in behalf of myself and my associates and fellow citizens, to extend to you the hand of fellowship, that you may have a very pleasant and profitable session here in our city, and that when you have returned to your homes you will have nothing but pleasant recollections of your visit with us. I thank you. *(Applause.)*

President.—I am sure that I represent the feelings of all our members and their families in thanking you, Mr. Richardson, for your cordial welcome, and that not the least of the many pleasing recollections of our visit to your beautiful sunny southland will be the friendly associations with yourself and fellow citizens already so happily inaugurated.

President.—The next order of business is the roll call which is handled by a system of registration. Cards for the purpose will be found on the table, at the rear of the hall, and all are urged to fill them out and place them in the box on that table.

Members Present.

Aldrich, G., N. Y. N. H. & H. R. R., Boston, Mass.
Andrews, Geo. W., B. & O. R. R., Baltimore, Md.
Ashby, E. B., L. V. R. R., New York City.
Barrett, E. K., F. E. C. Ry., St. Augustine, Fla.
Beard, A. H., P. & R. Ry., Reading, Pa.
Bowers, S. C., Pa. Lines West, Steubenville, O.
Bowers, Stanton, P. C. C. & St. L. R. R., Bradford, Ohio
Brown, J. B., K. C. C. & S. Ry., Clinton, Mo.
Cahill, M. F., S. A. L. Ry., Jacksonville, Fla.
Canty, J. P., B. & M. R. R., Fitchburg, Mass.
Clark, W. M., B. & O. R. R., Glenwood, Pa.
Crane, Henry, C. & N. W. Ry., Janesville, Wis.
Dupree, Jas., Sou. Ind. Ry., Crete, Ill.
Fake, C. H., M. R. & B. T. Ry., Bonne Terre, Mo.
Fullem, T. J., I. C. R. R., Chicago, Ill.
Geary, S., Pa. Lines West, Cambridge, O.
Hadwen, T. L. D., C. M. & St. P. Ry., Chicago, Ill.
Hofecker, P., L. V. R. R., Auburn, N. Y.
Hubbard, A. B., B. & M. R. R., Boston, Mass.
Hudson, B. M., C. R. I. & G. Ry., Ft. Worth, Tex.
Jutton, Lee, C. & N. W. Ry., Chicago, Ill.
Kelly, C. W., F. M. & Co., Chicago, Ill.
Killam, A. E., Intercolonial Ry., Moncton, N. B.
Killian, J. A., Southern Ry., Charlotte, N. C.
King, A. H., O. S. L. Ry., Salt Lake City.
Large, C. M., P. R. R., Jamestown, Pa.
Large, H. M., G. R. & I. R. R., Ft. Wayne, Ind.
Lemond, J. S., Southern Ry., Charlotte, N. C.
Lichty, C. A., C. & N. W. Ry., Chicago, Ill.
Markley, A. S., C. & E. I. R. R., Danville, Ill.
Markley, J. H., T. P. & W. Ry., Peoria, Ill.
McIntyre, Jas., Miami, Fla.
McKeel, W. S., G. R. & I. R. R., Grand Rapids, Mich.
McLean, Neil, Erie R. R., Huntington, Ind.
McNab, A., P. M. R. R., Holland, Mich.
Miller, A. F., Pa. Lines West, Chicago, Ill.
Moen, J. D., C. & N. W. Ry., Boone, Ia.
Moore, W. H., N. Y. N. H. & H. R. R., New Haven, Conn.
Morgan, J. W., Southern Ry., Columbia, S. C.
Musser, D. G., Pa. Lines West, Wellsville, O.
Noon, W. M., D. S. S. & A. Ry., Marquette, Mich.
O'Neill, P. J., L. S. & M. S. Ry., Adrian, Mich.
Patterson, S. F., B. & M. R. R. Concord, N. H.
Pickering, B. F., B. & M. R. R., Sanbornville, N. H.
Powers, G. F., Joliet, Ill.
Reid, R. H., L. S. & M. S. Ry., Cleveland, O.
Richey, C. W., P. R. R., Pittsburg, Pa.
Riney, M., C. & N. W. Ry., Baraboo, Wis.
Scheetz, F. B., Mo. Pac. Ry., St. Louis, Mo.
Sheldon, J. B., N. Y. N. H. & H. R. R., Providence, R. I.
Sharpe, D. W., N. Y. N. H. & H. R. R., New Haven, Conn.
Spencer, C. F., L. I. R. R., Jamaica, N. Y.
Staten, J. M., C. & O. Ry., Richmond, Va.

Soles, G. H., P. & L. E. R. R., Pittsburg, Pa.
Storck, E. G., P. & R. Ry., Philadelphia, Pa.
Strouse, W. F., B. & O. R. R., Baltimore, Md.
Thomas, C. E., I. C. R. R., Chicago, Ill.
Weise, F. E., C. M. & St. P. Ry., Chicago, Ill.
Welker, G. W., Southern Ry., Alexandria, Va.
Winter, J. L., S. A. L. Ry., Waldo, Fla.
Wise, E. F., Waterloo, Ia.
Wright, C. W., L. I. R. R., Jamaica, N. Y.

The following applicants for membership, subsequently elected, were also present:

Barker, W. M., S. A. L. Ry., Scotia, S. C.
Brown, Alf, St. L. R. M. & P. R. R., Raton, N. M.
Cahill, P. W., S. A. L. Ry., Fernandina, Fla.
Christy, B. B., S. A. L. Ry., Tallahassee, Fla.
Dodd, A. M., C. of Ga. Ry., Columbus, Ga.
Gooding, W. J., S. A. L. Ry., Jacksonville, Fla.
Griffith, F. M., C. & O. Ry., Covington, Ky.
Jennings, G. H., E. J. & E. Ry., Joliet, Ill.
Land, B. Jr., S. A. L. Ry., Jacksonville, Fla.
Mahan, Wm., W. & L. E. R. R., Canton, O.
Meyers, W. F., C. & N. W. Ry., Belle Plaine, Ia.
Nelson, J. C., S. A. L. Ry., Portsmouth, Va.
Powell, C. E., C. & O. Ry., Hinton, W. Va.
Rice, A. P., C. N. & L. R. R., Columbia, S. C.
Salisbury, J. W., A. C. L. R. R., Port Tampa, Fla.
Smith, G. B., S. A. L. Ry., Woodbine, Ga.
Taylor, F. A., B. & O. R. R., Cumberland, Md.

President.—Next in order is the reading of the minutes.

Mr. Reid.—As the minutes of the last meeting were printed in the proceedings, I move that their reading be dispensed with.

Motion duly seconded and carried.

President.—Next is the report of the committee on membership.

Mr. Lichty.—I think it might be well to defer this until this afternoon, as there will probably be some additional members, and I will then present a complete report.

There being no objection it was so ordered.

President.—Next in order is an address by the president.

THE PRESIDENT'S ADDRESS.

Fellow Members:—When submitting the program for this convention to the officers and executive committee of our association for approval, a line of thought was awakened by the remark of a member of the before-mentioned committee, which resulted in furnishing a subject for this address.

This member, in his letter to me, referring to our proposed schedule, stated: "I trust that the time allowed for the meetings will be sufficient to do the actual work of the convention."

It immediately occurred to me that, perhaps, we were overdoing the jollification part in our suggested program but, having later given the subject much careful attention, I now feel, however, that we have been traveling on the right road.

Any attempt to enlarge on our customary number of reports and discussions is to be condemned, as this tendency would result, if carried out, in actually eradicating many advantages which our conventions now offer to some of our members. Perhaps, it may be advisable to shorten our formal technical program. Your attention is called to the fact that, for several years past, the American Society of Civil Engineers have limited their discussions of technical subjects to such an extent as to materially shorten their program in this respect, and the time at their annual meetings is now considerably devoted to excursions and social gatherings.

Some of you have perhaps heard people remark that conventions of organizations similar to ours have developed into gatherings conducted bv the supply men. There may be apparently good foundation for criticisms being applied by those who obtain only a superficial view of such meetings, but, to those who probe beneath the surface, the real character of our conventions is presented.

Our meetings are truly representative of the maintenance of railway bridges and buildings and most of our members feel, I am sure, that they derive much good in an educational way from this organization.

The excursion events in the programs, without a doubt, are conspicuous. These annual meetings offer to many of us our only opportunity to obtain a vacation. Neglect to appreciate this properly in making out programs would be quickly apparent in the growth of this association. The sight-seeing trips and other events on the schedules provided each year, outside of strictly technical work, can not be called time given over to pleasure wholly, as these outings are highly useful in permitting groups of men having mutual interests to discuss their problems informally. These quiet gatherings are not especially noticeable, except to the close observer, but, nevertheless, they are continually being held at every convention. It may be that, to many of us, these side meetings are of the greatest importance, as we are enabled to get in close touch, thereby, with men from different parts of the country and talk over the troublesome features of work to much better advantage than can be done in the convention hall. Furthermore, there are some features of the administration of railroads that can not be properly discussed except at these informal gatherings.

The quality of the men comprising the membership and the healthy, steady growth of this association is ample evidence that our policy has been correct. In order to show that the membership

of our association represents in no limited way the maintenance of railway bridges and buildings, I have made a classification of the member under separate headings as follows:—

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From 1892 to 1902 membership of this association increased gradually from 112 to 171. Since 1902 our growth has been rapid, until we now have an enrollment of 368 members, from over 100 railroads, representing 197,409 miles of road in the United States, Canada, Mexico, Australia and New Zealand.

Before closing my remarks, I feel it is my duty to state that no small praise for the past success and present all-around healthy condition of this association is due to our Secretary, Mr. S. F. Patterson. It may be a surprise to some, and I am positive it will be painful to all of you, to learn that our good old friend, familiarly known as the "Deacon," having decided to give up his position as secretary, handed in his resignation to the executive committee at their meeting in Chicago last March. It is my desire that the association at this convention, consider thoroughly the 18 years of labor of our worthy scribe and that suitable action be taken by us to show our appreciation of his past efforts.

With these few statements in regard to general conditions, I will now close my remarks and proceed with the program of the convention.

President.—Next in order is the report of the executive committee.

REPORT OF EXECUTIVE COMMITTEE.

To the Officers and Members of the American Railway Bridge and Building Association:

A session of the executive committee was called to order by President Canty at the close of the Washington convention last year. The secretary was instructed to procure a new seal, stationery.

etc., and to continue to pay bills as heretofore, holding receipts for vouchers.

Moses Burpee, J. P. Snow, and J. B. Sheldon were appointed a committee on publication. On motion, the president was instructed to appoint a sub-committee of three members of the executive committee to select designs for badges, and to purchase the same. No further business appeared and the meeting adjourned.

An executive committee meeting was called to order by President Canty at the Auditorium hotel, Chicago, March 16, 1909. All members, except one, were present. Mr. M. F. Cahill made a verbal report of progress on the program for our next convention, and recommended the Windsor Hotel, at Jacksonville, Fla., as the best. There was discussion in regard to transportation for the side trip, and it was left with the local committee to arrange all entertainments, and excursions, and, if necessary, issue a circular, informing members in regard to transportation. Such information was given in the official program. Secretary Patterson read a report stating that the present condition of the association was prosperous, and offered his resignation as secretary, to take effect at the close of the present term. The report was accepted, and placed on file.

The committee on badges reported progress and asked further time. On motion, the president was instructed to appoint a committee of one or more to get designs for a new certificate of membership and application blank. On motion, the secretary was instructed to print a program for our next convention, including a list of names, numbered in the order which they joined the association, also an alphabetical directory, the committee on badges to provide numbers for each member.

Hotel Windsor, Jacksonville, Fla., was, on motion, voted as the place for our next convention.

Notice of amendment to constitution was given.

No further business appearing, the meeting adjourned.

An executive committee meeting was called to order by the president Monday evening, Oct. 18, 1909, at 8 o'clock P. M., at the Windsor Hotel, in Jacksonville, Fla. A quorum was not present, but about 12 members were in attendance.

Remarks were made by Mr. Richardson, secretary of the board of trade, outlining the entertainment they wished to give us, and noting some of the attractions of the city.

No special business was transacted, but a general discussion on the welfare of the association was carried on.

Adjourned.

S. F. Patterson,
Secretary.

Mr. A. S. Markley.—I move that the report be accepted and printed in the proceedings.

Motion duly seconded and carried.

President.—Next is the annual report of the secretary.

SECRETARY'S REPORT.

Concord, N. H., Oct. 15, 1909.

To the Officers and Members of the American Railway Bridge and Building Association:

I submit the following report for the year ending, October 19, 1909:

Eleven hundred copies of the proceedings of the eighteenth annual convention, held at Washington, D. C., were distributed to members in our own country, and to those residing in Canada, Mexico, Australia, New Zealand and India. Complimentary copies were also sent to Paris and London, and by request, to several library associations abroad.

We have now on our roll 364 names, death having claimed four during the year, namely:

Mr. J. E. Johnson, of the Rutland R. R., Rutland, Vt., died Feb. 13, 1909.

Mr. R. L. Heflin, of the Lehigh Valley R. R., Sayre, Pa., died March 1, 1909.

Mr. W. J. Mellor, of the Morgan's Louisiana & Texas R. R. & S. S. Co., LaFayette, La., died June 20, 1909.

Mr. E. T. Welch, of the Chicago, St. Paul, Minneapolis & Omaha Ry., Mankato, Minn., died October 9, 1909.

The memoir committee will make proper mention of each.

About 100 members were in attendance at the Washington meeting. A pleasant feature of the convention was the reception by President Roosevelt, a privilege which was appreciated by all.

In resigning my position as secretary, I am pleased to be able to state that the financial condition of the association is satisfactory, that the membership is steadily increasing, and the interest of the members shows no diminution; and although we do not call ourselves a "brotherhood," yet the spirit of unity which prevails in our intercourse might rightfully entitle us to that name.

I bespeeak most cordially for my successor, the support and loyal co-operation which has characterized the relations between me and the members of the association for eighteen years, and I wish to say that, although now no longer an office holder, my good wishes and my affection for the many friends made during that period will know no change while I am spared to take an interest in the affairs of the association.

FINANCIAL.

DR.

Cash balance in my hands last report,	$ 246.73
Cash received for fees and dues,	773.00
Cash received for sale of books,	25.01
Cash received for advertisements,	1,493.90
Total receipts,	$2,538.64

CR.

By cash paid out, for which I hold vouchers,	$2,421.50
Balance in my hands,	$117.14

Respectfully submitted,
S. F. Patterson,
Secretary.

Mr. Killam.—I move that the report be accepted and referred to the auditing committee, and printed in the proceedings.

Motion was duly seconded and carried.

Secretary.—I have here letters from the following members, expressing their regret at inability to be with us at this convention: Mr. W. A. McGonagle, President D. M. & N. Ry.: Mr. C. P. Austin, (treasurer) B. & M. R. R.: Mr. C. W. Vandegrift, C. & O. Ry.; and Mr. J. N. Penwell, L. E. & W. Ry.

The following letter from the treasurer, Mr. C. P. Austin, was read:

Lawrence, Mass., Sept. 28, 1909.

Mr. J. P. Canty, Fitchburg, Mass.,

Dear Sir: On account of sickness in my family I regret that I will be unable to attend the meeting at Jacksonville in October.

I hereby tender my resignation as treasurer of the association, to take effect at this meeting, and will turn over the bank books and records or withdraw the deposits and send to my successor or to whom the executive committee shall direct.

Yours truly,
C. P. Austin,
Treasurer.

President.—Next in order is the treasurer's report.

TREASURER'S REPORT.

Lawrence, Mass., Oct. 15, 1909.

To the Officers and Members of the American Railway Bridge and Building Association:

I beg leave to submit the following report for the year ending October 18, 1909:

DR.

Cash on hand last report,	$1,358.61
Interest, Medford savings bank, to May, 1909,	42.74
Interest, Lawrence savings bank, to April, 1909,	6.00
Received from secretary, July 8, 1909,	200.00
Received from secretary, Aug. 31, 1909,	300.00
Total on hand,	$1,907.35

Respectfully submitted,
C. P. Austin,
Treasurer.

Mr. A. S. Markley.—I move that the report be accepted and referred to the auditing committee, and printed in the proceedings.

Motion duly seconded and carried.

President.—Next in order is the report from the relief committee. There is no report, and I presume one was unnecessary. Next in order is the appointment of committees, which I will name as follows: Auditing committee, C. W. Richey, C. H. Fake. and E. G. Storck. Committee on resolutions, R. H. Reid, J. H. Markley. and W. F. Strouse. Obituary committee, G. W. Andrews, A. B. Hubbard and J. S. Lemond.

President.—Next in order is the report from the committee on memoirs.

REPORT OF COMMITTEE ON MEMOIRS.

To the Officers and Members of the American Railway Bridge and Building Association:

Once more in our busy lives we are reminded that we are born to die after a few short years of activity. During the last year, four of our members have been called to a permanent home where they are beyond our praise or censure.

Our committee begs leave to submit the following memoirs and recommends that a copy be sent to the families of our departed friends and that a copy be printed in the proceedings of this convention.

J. N. Penwell,
Committee.

MEMOIR.

James E. Johnson, supervisor of bridges and buildings of the Rutland Railroad, was a charter member of this Association. He died at his home in Rutland, Vermont, on Feb. 13, 1909, of Bright's disease, after an illness of several months. He was born in Clinton, Ohio, Sept. 28, 1856, and was a son of James Ross Johnson and Martha Rose Johnson. He attended school in Clinton, until 14 years of age, when his mother died. After the death of his mother, Mr. Johnson went to work on the Lake Shore & Michigan Southern Ry.

At the age of 18 Mr. Johnson left the Lake Shore system and entered the employ of the Iowa Central Ry., remaining with that company for five years. He then returned to the L. S. & M. S. Ry., remaining there several years. Later he went to work for the Massillon Bridge Company, in Toledo, Ohio. In 1888, Mr. Johnson became superintendent of bridges and buildings for the Toledo, St. Louis & Kansas City Railroad, remaining with that company 10 years. He then accepted a similar position on the Rome, Watertown and Ogdensburg division of the New York Central lines, later being transferred to the New York offices. In 1903 he resigned his New York position and took up the position in Rutland, which he held at the time of his death.

Mr. Johnson was married in 1878 to Miss Laura Belle Lewis, of Sharon, Ia., who survives him. He also leaves one daughter, Mrs. William Waddingham of Watertown, N. Y.

He was a member of Vermont Lodge No. 1, Knights of Pythias, and this order had charge of the funeral, which was held at his late residence, and the body was placed in the vault at Evergreen Cemetery.

MEMOIR.

Robert L. Heflin who was elected a member of this association at Philadelphia, in 1893, died suddenly at his home in Sayre, Pa., March 1, 1909, of apoplexy. Mr. Heflin was born in Fauquier Co., Va., Jan. 22, 1847. He moved from his boyhood home to Grafton, W. Va., in 1878, where he resided until 1901. He was a member of high degree and honor in the order of F. and A. M., having served in many high and honorable positions. He was a Christian of good standing, having been a member of the church for forty-three years.

R. L. Heflin.

For more than twenty years he was employed by the Baltimore & Ohio Railroad Co., first as foreman of construction, and later as supervisor of bridges and buildings. He left the service of the company in August, 1901, to accept a similar position with the Lehigh Valley Railroad, with headquarters at Sayre, Pa. He resigned his position some time before his death on account of ill health.

He leaves a wife, also two children by a former marriage, they being Mrs. D. K. Keller, and Caroll Heflin, both of Sayre, Pa. The funeral services were held at Sayre, in charge of the Sayre Commandery Knights Templar.

MEMOIR.

William J. Mellor, elected a member of this Association in 1904, died suddenly at his home, 3627 Magazine St., New Orleans, La., June 20, 1909.

He was born in Northumberland County, Pa., July 10, 1861. He was educated in the public schools of his home county and shortly after leaving school, in 1879, he left home and went to Colorado. In 1880 he removed to California and accepted service with the Southern Pacific Company, in that state. In 1882 he went to Texas and still worked for the same company in Houston, in the capacity of foreman of bridges and buildings, later being made superintend-

W. J. Mellor.

ent of construction of bridges and buildings of the Beeville extension of the San Antonio & Aransas Pass Ry.

In 1889 he was sent to western Texas to reconstruct a lot of iron bridges, the principal ones of which were the crossing of the Southern Pacific over the Rio Grande river and the famous high trestle over Pecos river, which is 321 feet high and 2,271 feet long. After successfully carrying out this work he moved to Houston, Tex., and was made foreman of shops, in which capacity he was employed until July 1, 1898, when he was appointed superintendent of bridges and buildings of the Louisiana lines of the Southern Pacific Company with headquarters at LaFayette, La.

From July 1, 1898, to the day of his death Mr. Mellor made his home in New Orleans, La. His principal work of importance in

that state was the construction of the S. P. crossing over the Calcasieu river and the construction of the S. P. crossing over Berwick bay, which was described in the columns of the association's report of proceedings of the 18th annual convention.

Mr. Mellor was married in 1892 to Miss Laura Bean of Langtry, Tex., and is survived by his wife and three children, Charles Roy, Ruth May, and William Jesse.

The interment took place at Metarie Cemetery, in New Orleans. The funeral was held at the Louisiana Avenue Methodist church, and, being a member of the Benevolent and Protective Order of Elks, his brothers of that order were in charge of the ceremonials.

E. T. Welch.

MEMOIR.

E. T. Welch, supervisor of bridges and buildings of the Chicago, St. Paul, Minneapolis & Omaha Railway, died October 9, 1909. He was elected a member of this association in 1907, at the Milwaukee meeting.

Mr. Welch was born in Monticello, Iowa, October 10, 1861. He was operating a gasolene motor car about ten miles from his home in company with his water supply foreman when the car collided with a light engine; both men jumped, but when the engine struck the car it was thrown upon Mr. Welch, killing him instantly.

He left home at the age of 17 and entered the service of the Great Northern Railway, in the bridge and building department,

with headquarters at Crookston, Minn., where he continued service until 1894. He then entered the employ of the Chicago, St. Paul, Minneapolis & Omaha Railway as a bridge carpenter at Mankato, Minn., and in 1903 was appointed supervisor of bridges and buildings of the eastern district of the Minnesota & Iowa division, continuing in that position to the time of his death. He left a wife and three daughters, the oldest daughter being 16 years of age and the youngest, 7 years. The residence is at 410 Cross St., North Mankato, Minnesota.

Report was received and ordered printed in the proceedings.

Mr. A. S. Markley.—I move that we adjourn until 2 o'clock this afternoon.

Motion was duly seconded and carried and adjournment taken until afternoon session.

AFTERNOON SESSION.

TUESDAY, October 19, 1909.

President.—I have here an invitation from the Turpentine Operators' Association, to representatives of this association to a supper to be given at their rooms tomorrow evening at 7:00 P. M. It was thought advisable, in place of giving a general invitation to all the members, that the president should appoint a delegation to go there and represent this Association. I have therefore appointed the following to attend that banquet at 7:00 P. M., tomorrow evening, at the Masonic Temple: Messrs. B. F. Pickering, G. W. Andrews, R. H. Reid, J. H. Markley, D. C. Zook and A. E. Killam.

President.—Now I think we had better have a resume of the arrangements that have been made for us by the entertainment committee.

Mr. Cahill, the chairman of the entertainment committee, then outlined the arrangements which had been made. These reflected credit on himself and the committee and could not be other than eminently satisfactory to the members and their families.

President.—We will now receive the report of the membership committee.

REPORT OF MEMBERSHIP COMMITTEE.

To the Officers and Members of the American Railway Bridge and Building Association:

The committee, during the summer months, sent out 670 copies of the following circular:

Chicago, Aug. 1, 1909.

This association was organized in 1891, and at present has 368 members, including superintendents, engineers, master carpenters, general foremen, etc., representing over 197,000 miles of railroads in the United States, Canada, Mexico, Australia, New Zealand and India.

Article II of the constitution reads as follows:

Section 1. The object of this association shall be the advancement of knowledge pertaining to the principles, design, construction and maintenance of railway bridges, buildings and other structures, by investigation, reports and discussion of the experience of its members and others, and to provide a means of exchange of ideas, so that bridge and building practice may be systematized and improved.

If you are not a member of this association you are invited to send in an application, and if possible be in attendance at the next annual convention to be held at Jacksonville, Florida, Oct. 19-21, 1909.

There are no official obligations or detrimental conditions attached to membership. The work of the association is purely the spreading of knowledge and information by reports and discussions on specially selected subjects bearing directly on the methods and appliances which enter into the routine work of the bridge and building department of a railroad.

The membership fee is $3, and annual dues $2. If you will send draft for $5, together with application, to the secretary, Mr. S. F. Patterson, Concord, N. H. (which will include your dues paid up to Oct. 1910), he will forward to you a program for the coming convention, and a copy of the proceedings (326 pages) of the last convention, held at Washington, D. C., Oct. 1908.

Appropriate badges are furnished members and their wives, who attend the convention, free of charge.

Many members make this their annual vacation trip and enjoy a good and profitable time generally. You are invited to bring the ladies with you. There is always a goodly number in attendance and they are afforded means of entertainment while the members are in session.

It is customary, during and after the convention, to visit places of local interest, such as docks, shops, factories, historical points, etc. A special committee has charge of arrangements for side trips, entertainment and hotel accommodations. It is intended this year to take a side trip to St. Augustine, Palm Beach, Miami and the Florida Keys, over the Florida East Coast Ry., which presents one of the most difficult and interesting feats of concrete construction in the world at the present time.

The Pullman Co. offers half rates to members and their families who attend the convention. This will be explained more fully in the program, as well as the matter pertaining to transportation, which can be had upon application to the secretary.

The association is in a prosperous condition. The leading motive for the issuance of this invitation is solely the laudable desire to enlarge the sphere of work and usefulness of the association by increasing the membership, thereby giving additional weight and influence to its work and enabling the association to become more truly representative of the various interests centering in the bridge and building department of all the prominent railroad systems of the country.

Further information cheerfully furnished by the undersigned.

(Signed by Committee.)

These circulars were printed on four pages, pamphlet style, with the list of officers on the first page, the announcement on pages 2 and 3, and the list of subjects for report and discussion at the forthcoming convention on the fourth page.

The names of 37 applicants follow, all of whom are recommended for election at this meeting:

BARKER, W. M., Br. Foreman, Seaboard Air Line Ry., Scotia, S. C.
BROWN, ALF, Supt. B. & B., St. Louis Rocky Mt. & Pac. R. R., Raton, N. M.
CABLE, C. C., Engineer Construction, Havana, Cuba.
CAHILL, P. W., For. Carpenter, S. A. L. Ry., Fernandina, Fla.
CATCHOT, A. J., Supvr. B. & B., L. & N. R. R., Ocean Springs, Miss.
CHRISTY, B. B., Br. Foreman, S. A. L. Ry., Tallahassee, Fla.
DODD, A. M., Supvr. B. & B., Central of Ga. Ry., Columbus, Ga.
DONALDSON, CLAUD, For. B. & B., Central Vt. R. R., Waterbury, Vt.
DOUGLAS, WALTER JULES, Engr. of Bridges, D. C., Washington, D. C.
FRASER, ALEX, Supvr. B. & B., Sou. Pac. Co., Bakersfield, Cal.
GOODING, JR., W. J., Div. Engr. S. A. L. Ry., Jacksonville, Fla.
GRIFFITH, F. M., Supvr. B. & B., C. & O. Ry., Covington, Ky.
HAND, GEO. W., Asst. Engineer, C. & N. W. Ry., Chicago.
JENNINGS, GEO. H., Supt. B. & B., E. J. & E. Ry., Joliet, Ill.
JEWELL, J. O., Supt. B. & B., Sou. Ind. Ry., Terre Haute, Ind.
KINZIE, H. H., Br. Supervisor, N. Y. N. H. & H. R. R., Taunton, Mass.
LAND, B., JR., Div. Engr., S. A. L. Ry., Jacksonville, Fla.
LARSON, JOHN, M. of W. Inspector, Mo. Pac. Ry., St. Louis, Mo.
LEE, FRANK, Div. Engr., Can. Pac. Ry., Winnipeg, Manitoba.
McDEARMID, W. A., For. Bridges, S. A. L. Ry., Tallahassee, Fla.
MAHAN, WM., Master Carpenter, W. & L. E. R. R., Canton, Ohio.
MEYERS, W. F., For. B. & B., C. & N. W. Ry., Belle Plaine, Iowa.
NELSON, J. C., Engr. M. of Way, S. A. L. Ry., Portsmouth, Va.
NUELLE, J. H., Asst. Engr., N. Y. O. & W. R. R., Norwich, N. Y.
PHILLIPS, B. P., Asst. Suprv. Bridges, N. Y. N. H. & H. R. R., Willimantic, Conn.
POWELL, C. E., Supt., B. & B., C. & O. Ry., Hinton, W. Va.
REDFIELD, J. A. S., Res. Engr. C. & N. W. Ry., Hawarden, Ia.
RICE, A. P., Roadmaster, C. N. & L. R. R., Columbia, S. C.
ROHBOCK, W. L., Asst. to Ch. Engr., W. & L. E. R. R., Cleveland, Ohio.
SALISBURY, J. W., Gen. For. Docks & Wharves, A. C. L., Port Tampa, Fla.

SCHAFFER, JOHN, Supvr. B. & B., N. Y. C. & H. R. R. R., Rochester, N. Y.
SMITH, GLEN B., For. Water Stations, S. A. L. Ry., Jacksonville, Fla.
TAYLOR, D. B., Master Carpenter, B. & O. R. R., Wheeling, W. Va.
TAYLOR, F. A., Master Carpenter, B. & O. R. R., Cumberland, Md.
TOOHEY, J. E., Gen. For. B. & B., P. M. R. R., Grand Rapids, Mich.
WILSON, JAS. A., Br. Foreman, S. A. L. Ry., Woodbine, Ga.
WOOD, W. B., Supvr. B. & B., Mo. Pac. Ry., Atchison, Kansas.

Respectfully submitted,
C. A. LICHTY,
Membership Committee.

Mr. A. S. Markley.—I move that the report be accepted and that the secretary be authorized to cast one ballot admitting these gentlemen as members of the association.

The motion was duly seconded and carried and ballot cast by the secretary, and the applicants were declared duly elected members of the association and entitled to all the rights and privileges of the association. Recess was then taken, giving an opportunity to meet the new members present, after which the meeting was again called to order by the president.

President.—We will now have read the report of the committee appointed to secure new badges and number identification buttons.

REPORT OF COMMITTEE ON BADGES.

The committee on badges, after canvassing various designs and being in communication with several firms making a specialty of manufacturing such emblems, united in recommending the adoption of a shield design bearing the name of the association. This the Whitehead & Hoag Co. offered to make at a cost of 48 cents each. This design having been approved by you, 200 badges in blue enamel for members and 100 in red for the ladies were procured. As per your instructions 400 number buttons, numbered from 1 to 400, for identifying members were also purchased. Further badges can be secured from the manufacturers as desired for 40 cents each, and they offer to make a solid gold badge of same design for $1.25 if we should wish it. Having selected and secured the necessary badges your committee would respectfully ask to be relieved.

T. L. D. HADWEN,
T. J. FULLEM,
C. A. LICHTY,
Committee.

Informal discussion then followed as to parties entitled to hold ladies' badges, method of distribution, etc.

Mr. Andrews.—I make the motion that badges for families be given our wives, and that any which may be desired for daughters shall be given out only to such as are present at a convention.

Mr. Aldrich.—I would like to make as an amendment that they be provided for sons also.

Further informal discussion took place regarding changes desirable in the reading of the above motion and amendment, which were accepted by Messrs. Andrews and Aldrich, and the revised motion put before the association by the president which was duly seconded and carried, reading as follows: " Badges for families shall be given to the wives of members and to such other immediate relatives only as may be present at a convention."

(See subsequent action taken by executive committee at their meeting of October 21, 1909, directing the secretary to give out family badges to the wives of members as they might be called for, but that those desired for other relatives should be given out only during the convention period, upon application of a member of this association, who would be held responsible for their return to the secretary at the close of the convention.)

Mr. Pickering.—I move you that none of the distinctive members' badges be distributed to any one who is not an actual member of this association.

Motion was duly seconded and carried.

President.—Is there any more new business to come up before the Convention?

Mr. A. S. Markley.—Would not the proposed changes in the constitution and by-laws come under that head?

President.—You have all received printed copies of the proposed amendments. What do you wish to do with them?

Mr. Pickering.—I move you that we amend Section 1, Article VII of the constitution to read:

After each annual meeting the president shall appoint a committee of five members, not officers of the association, of whom two at least shall be past presidents, and two of whom shall have served on the committee the previous year, who shall prepare a list of names of nominees for officers to be voted on at the next annual convention, agreeable to Article VI of this constitution, said list to be read at the first session of the second day of said convention. Nothing in this section shall be construed to prevent any member making nominations.

Mr. A. S. Markley.—I second the motion to revise Section 1 of Article VII as read by Mr. Pickering. Motion carried.

Mr. Pickering.—Referring to the proposition to amend Section 5 of Article VII: I believe there has been some misunderstanding here and do not think that the section as it stands needs to be amended. The publishing committee has edited their work in past years, and it has been very satisfactory, but if we get it in the constitution that this publishing committee is empowered to employ some competent person to edit these proceedings, I think that is all right. The amendment recommended is that the president shall appoint an editing committee of one active member of this association. Now I think, Mr. President, that you will find it almost impossible to select an active member of this association who is competent to do this work, who has not already more work than he can do, and I believe therefore that the publishing committee should leave this to some competent person, and I have some one in mind now who has attended all our meetings for years and who is familiar with our proceedings and can do it. Therefore I move you that we do not amend Section 5 of Article VII.

Mr. Lichty.—I will offer this amendment. After our annual meeting the executive committee shall appoint an editor to edit the proceedings of the association. Compensation for the services of the editor shall be fixed by the executive committee.

Mr. Pickering.—I will withdraw my motion and if Mr. Lichty will make that as a motion I will second it.

Mr. Lemond.—It appears to me that a man not familiar with this line of railroad business would not be competent to do this work. I think that an active member should be employed with authority to employ some one to assist him. By doing this you have an experienced man on the work and he can hire a capable assistant.

Mr. Pickering.—I see Mr. Lemond's point and I think it is a good one. The old section is in line with Mr. Lemond's suggestion and is, I think, even better, as it leaves it to an editing committee empowered to employ a man competent to edit the proceedings. I move you, Mr. President, that the section stand as it is at present.

Mr. Lichty.—I will withdraw my motion.

President.—As the matter now stands there is no motion before the house to change Section 5 of Article VII.

Mr. Pickering.—As a matter of record I move you that it is inexpedient to amend Section 5 of Article VII of our constitution.

Motion was duly seconded and carried.

President.—I have here a letter from Mr. James Stannard as follows:

Kansas City, Mo., Sept. 21, 1909.

Members of the American Ry. B. & B. Ass'n., Jacksonville, Fla.:

I propose adding as another section relating to life membership, to read:

"Any brother who has paid dues in this association for twenty-five years shall become a life member and exempt from further payment of dues, and that the secretary issue to him a certificate of life membership under the seal of the association and to enter the same upon the records."

This will not interfere with the other section.

Signed, *James Stannard.*

President.—I presume this is equivalent to a notification that an amendment to the constitution will be in order. We will hold this on file until next year, when it will come up as unfinished business, and the members can state at that time whether or not they wish to adopt this as an amendment.

President.—Before we adjourn I wish to have the assistant secretary read the report of the auditing committee.

REPORT OF AUDITING COMMITTEE.

Jacksonville, Oct. 19, 1909.

To the Officers and Members of the American Railway Bridge and Building Association:

The committee has examined the books of our secretary and submit herewith the result of our audit.

DR.

Cash on hand last report,	$ 246.73	
Received in fees and dues,	773.00	
Received for sale of books,	25.01	
Received for advertisements,	1,493.90	
Total receipts,		$2,538.64

CR.

Miscellaneous expenses as per receipted bills,	$1,921.50	
Cash paid to treasurer,	500.00	
Total disbursements,		$2,421.50
Cash on hand,		117.14

C. W. Richey,
C. H. Fake,
E. G. Storck,
Committee.

Mr. A. S. Markley.—I move that the report be accepted and printed in the proceedings.

Motion duly seconded and carried.

Mr. Staten.—I move that we adjourn until 9:00 A. M. tomorrow (Wednesday) morning.

Motion duly seconded and carried and adjournment taken.

MORNING SESSION.

Wednesday, October 20, 1909.

President.—Before we proceed to the discussion of the reports I wish to call your attention to a few letters I have received:

The first from the Atlantic Coast Line stating that their general superintendent, Mr. M. Riddle, at Jacksonville, will take pleasure in issuing free transportation to the members and their families upon certification of our secretary;

One from the Young Men's Christian Association extend-

ing a welcome and inviting our members to visit their new building across the square from the hotel;

One from Gonzalez & Sanchez, cigar manufacturers, inviting us to visit their large cigar factory while in the city.

President.—We will now proceed with the discussion of the reports.

The remainder of the forenoon session was taken up with the discussion of the reports, until about 11:30, when the following business was transacted:

President.—We have here report from the committee on nominations.

REPORT OF THE NOMINATING COMMITTEE.

Jacksonville, Oct. 20, 1909.

To the American Railway Bridge and Building Association:

The nominating committee presents the following list of names for officers and members of the executive committee for the ensuing year; it gives us pain to be obliged to substitute another name for that of our tried and faithful secretary, but as he absolutely declines a renomination we could not do otherwise:

President—J. S. Lemond, Southern Ry.
First Vice-President—H. Rettinghouse, C. & N. W. Ry.
Second Vice-President—F. E. Schall, Lehigh Valley R. R.
Third Vice-President—A. E. Killam, Intercolonial Ry.
Fourth Vice-President—J. N. Penwell, L. E. & W. Ry.
Secretary—C. A. Lichty, C. & N. W. Ry.
Treasurer—J. P. Canty, B. & M. R. R.
Executive Members—Willard Beahan, L. S. & M. S. Ry.; F. B. Scheetz, Mo. Pac. Ry.; T. L. D. Hadwen, C. M. & St. P. Ry.; T. J. Fullem, I. C. R. R.; G. Aldrich, N. Y. N. H. & H. R. R.; P. Swenson, "Soo" Line.

(Signed)

A. S. Markley,
B. F. Pickering,
J. B. Sheldon,
J. H. Markley,
R. H. Reid,
Committee.

President.—The report of this committee will be laid on the table until proper time for action.

Mr. A. S. Markley.—It was a matter of great regret to the members of this committee to part with the valuable services of "The Deacon," as secretary, in which position he has built up the proceedings of this association from nothing to where they are now and has done unfaltering

labor in putting our finances in their present condition; and I know that all the members who have known our friend feel the same as we of the committee do.

President.—I would like to see the association take some official action in drafting resolutions or something suitable to show our appreciation of Mr. Patterson's services for this association.

REPORT OF COMMITTEE ON SELECTION OF SUBJECTS.

The report of the committee on subjects for discussion is as follows:

1.—Method of protection to embankments against currents and of restoring the same when washed out.

2.—How to prevent iron pipe culverts from pulling apart in soft ground and how best to repair them when pulled apart.

3.—Concrete in railroad construction; kind of reinforcement and water proofing, when necessary.

4.—Standard arrangement of buildings and platforms for small towns, as to convenience and appearance.

5.—Best method of determining proper dimensions of openings for waterways.

6.—The best method of obtaining elevation on curves on bridges and trestles.

7.—The best method of numbering bridges.

8.—The economy and practicability of wire glass in round-houses, shops and station buildings.

9.—The best style and dimensions of hoops for water tanks in capacities from 50,000 to 100,000 gallons.

10.—Plans of fireproof oil houses for storing large quantities of oil at principal terminal stations.

(Signed)

W. M. Noon,
J. S. Lemond,
G. Aldrich,
C. E. Thomas,
A. B. Hubbard,
Committee.

President.—The report of this committee will be laid on the table until proper time for action.

Mr. A. S. Markley.—I move that this report be accepted.

Motion carried.

President.—I am glad to see that the committee has reduced the number of subjects to ten instead of thirteen, as we have them this year, as it is my opinion that it is better to have eight or ten subjects and give them thorough discussion.

Mr. Aldrich.—As one of the committee—I am not speaking authoritatively—it was generally considered that ten subjects were ample and that the standing subjects were just as well omitted; as we thought that if ten were thoroughly discussed that would be sufficient work for one meeting.

President.—When we adjourn, to-day, it will be to meet this evening at 7: 30 in the auditorium of the Board of Trade, where they will entertain us for a few moments with some stereopticon views. The regular meeting will commence at 8: 00 o'clock and continue until about 9: 30, after which the Board of Trade has arranged some other features for our entertainment.

Mr. A. S. Markley.—I move that we adjourn.

Motion duly seconded and carried and adjournment taken.

EVENING SESSION.

WEDNESDAY, October 20, 1909.

At Auditorium of Board of Trade.

President.—We will proceed at once to the discussion of subjects. (See discussion.)

President.—This ends all the subjects of 1908-1909. It has been customary to review the subjects of the past year. Possibly it would be well to take this up the first thing tomorrow morning.

President.—Now I understand that Mr. Jutton has something to say about the arrangements he has made with the railroad and Pullman companies.

Mr. Jutton then made detailed statement of tentative arrangements, unconcluded and awaiting the decision of the association, particularly with reference to the financial part to be borne by the association in chartering special cars.

An informal discussion followed in regard to this matter.

Mr. A. S. Markley.—I make the motion that this association recognize the arrangements inaugurated by its executive committee with regard to chartering and paying for special

cars and that Mr. Jutton and Mr. Patterson be authorized to conclude these arrangements on the best possible terms.

Motion duly seconded and carried.

Mr. Cahill.—I move that we adjourn.

Motion duly seconded and carried and adjournment taken, after which the Board of Trade, of Jacksonville, took charge of the proceedings and entered upon a program of entertainment which soon banished any lingering cares or thought upon business matters. All present were unanimous in considering this one of the most pleasant experiences of their visit to Jacksonville and voting their thanks to the Jacksonville Board of Trade members for their good fellowship and the royally good time given them in this evening's entertainment of fun and music, "Dutch supper" and other good things.

MORNING SESSION.

THURSDAY, October 21, 1909.

President.—As you all know it has been customary for us at these conventions to review the subjects up for report the previous year, and as yet we have done nothing on this. I will, therefore, take that up the first thing.

COMMITTEE REPORTS PRESENTED AT EIGHTEENTH ANNUAL CONVENTION.

Nos. 1 to 9 inclusive. No discussion.

STANDING SUBJECTS.

Nos. 1 to 6 inclusive. No discussion.

President.—This ends the discussion of all reports and subjects to be brought up at this convention.

President.—Next is the report of committee on resolutions.

REPORT OF THE COMMITTEE ON RESOLUTIONS.

Jacksonville, Florida, October 21, 1909.

To the Officers and Members of the American Railway Bridge and Building Association:

The committee on resolutions respectfully submits the following report:

Resolved, That the thanks of this association be extended to Mr. W. S. Jordan, mayor of Jacksonville, and to Mr. H. H. Richardson, secretary of the Jacksonville Board of Trade, for their able and entertaining addresses and words of welcome to their beautiful city;

To the Jacksonville Board of Trade, the Jacksonville Lumbermen's Association, and the Turpentine Operators' Association, whose generous entertainment of our members and their families have shown us the full meaning of the term "true Southern hospitality," and to Gonzalez & Sanchez Company cigar manufacturers and the Jacksonville Young Men's Christian Association for their further welcome and extension of courtesies;

To Mr. Thomas M. Wilson, proprietor, and Mr. C. H. Montgomery, manager of the Windsor Hotel, for their uniform and cordial treatment of our members and their families;

To the daily press for their interest in our proceedings;

To Mr. W. M. Camp, editor of the *Railway and Engineering Review,* for his attendance and helpful interest in our work at this and previous meetings;

To the railroad, Pullman, and other companies, individually and collectively, whose interest and co-operation have helped to make possible the results accomplished by this association;

To the Seaboard Air Line, the Pullman Company, the Atlantic Coast Line, the P. & O. Steamship Company, and the Florida East Coast Ry., for further courtesies shown our members while at Jacksonville; at the same time expressing our sincere regret and condolence to the Florida East Coast Ry. on the damage done by the recent hurricane to the temporary work on their great "Over the Sea" extension to Key West, and on which a trip by our members will be looked forward to at the nearest possible future;

To the officials and citizens of Nashville, Tennessee, for the cordial and spirited welcome accorded a delegation of our members who visited that enterprising city, en route;

To the different supply houses which made exhibits at the convention and to each and every member of the Supply Men's Association whose good fellowship and untiring efforts in behalf of our entertainment have made this and other conventions something to be looked forward to and remembered by both our members and their families.

R. H. Reid,
J. H. Markley,
W. F. Strouse,
Committee.

Upon motion duly seconded the report was accepted and ordered printed in the proceedings.

REPORT OF THE OBITUARY COMMITTEE.

Jacksonville, Fla., Oct. 21, 1909.

To the Officers and Members of the American Railway Bridge and Building Association:

Whereas, Our Almighty Father, in his divine wisdom has deemed it best to remove from our midst four of our respected members, thus reminding us of the shortness of life and the necessity of preparing for the one call that is sure to come, therefore be it

Resolved, That we deeply deplore and sincerely mourn the loss of these brothers: R. L. Heflin, J. E. Johnson, W. J. Mellor and E. T. Welch.

Resolved, That our secretary extend to the widows and families of our deceased brothers the sincere sympathy of this association and that a copy of these resolutions be printed in our proceedings and a copy sent to their respective families.

GEO. W. ANDREWS,
A. B. HUBBARD,
J. S. LEMOND,
Committee.

Upon motion duly seconded the report was accepted and ordered printed in the proceedings.

President.—This, gentlemen, finishes up all the committee work, so far as I know, and everything that we were to carry out at the present time except the choosing of a place for next year's convention. Nominations are now in order.

Detroit, Cleveland, Winnipeg, and Fort Worth, were then nominated.

President.—Gentlemen:—the result of your first ballot is Detroit 10; Cleveland 1, Winnipeg 7 and Fort Worth 35.

Mr. O'Neill.—Ft. Worth having a majority of all votes cast I move that it be made unanimous, and that Ft. Worth be declared the meeting place for our next convention.

Motion was duly seconded and carried.

President.—Next is the election of officers. I will reread the nominations as offered.

Mr. O'Neill.—If there is no opposition I move that the retiring secretary, Mr. S. F. Patterson, cast one ballot for the election of officers as nominated.

Motion was duly seconded and carried.

Mr. S. F. Patterson.—I cast that vote.

President.—The officers, as nominated, have been elected for the next year.

The president then called upon the officers-elect and requested each to assume the office to which he was elected. All those present accepted.

Mr. Lemond.—Gentlemen:—I presume that we should finish up the business with as little delay as possible. In accepting the highest office in our association, I am not unmindful of the honor bestowed, and would be ungrateful if I failed to appreciate it and put forth my best efforts for the advancement of its interest. I thank you for the confidence thus bestowed.

Some of you will no doubt recall the statement I made at the March meeting of the executive committee at Chicago, that I feared we had made a mistake in adopting our new constitution so far as it related to the eligibility of the president for only one term, as it would debar some of the best men in the association from being re-elected, and your selection of a presiding officer today emphasizes that fact very clearly; but you, and not I, have the responsibility. With your assistance, however, I will endeavor to sustain the reputation of the association.

To have a successful association it is necessary to have the support of the entire organization, and I sometimes think that those of us not assigned to active committee work are not as prompt in giving the committeemen the help we should when called on for our views and other assistance. We are, of course, busy men, but none is so busy as not to be able to devote enough time to so good a cause as we represent, and I most earnestly request that we make a special effort to do this in the future and keep up the splendid reputation of this organization. I thank you.

Mr. Andrews.—Away back in 1892 the members of this association went to Cincinnati and there I met a certain gentleman of whom I will tell you. At that time there were but three men from east of the Ohio river, and one of these was the gentleman who is our honored retiring secretary. I have been closely associated with him in the business of this association since that time, until the present, and while

I have been a member of many other organizations I have never met with any one who did such sincere loyal work as has our retiring secretary, "The Deacon." A great many of you are no doubt familiar with how he got the term "Deacon." At that first meeting our good friend came dressed in black, with a Prince Albert coat, a white tie and plug hat. One of our members came in quietly and said: "Shh—!!, be quiet, boys, exercise care, we have a preacher with us." If I had the power I could stand here for an hour and praise "The Deacon," but I claim that you will all agree with me that it would be impossible for us to say too much. Instead of allowing him to retire, I move that he be elected Secretary Emeritus, with a salary sufficient to take care of all his expenses in attending our future meetings, which I hope will be for many years.

Mr. A. S. Markley.—I would like to second the motion that was just made, and I believe there is not a man here who will not be glad to have our good friend with us at our future meetings.

Mr. Killam.—I feel that I cannot allow this occasion to go by and not endorse what has been said of our honored friend, "The Deacon." I have had the pleasure of meeting with him the last twelve years. I remember well receiving from him in my mail one morning the prospectus of this society, and as soon as I had looked it over I said, this is something that I want to join. I have known our honored friend from that time to this and I am going to say now that no more worthy or better friend exists on either side of the line—and, in fact, there is no line except when you want to ship a car of goods—so that I fully endorse what has been said of our worthy friend, Mr. Patterson, and could even say more were it possible to do so.

Mr. Andrews.—My motion was that we elect our retiring secretary, Mr. S. F. Patterson, Secretary Emeritus, with a salary at least sufficient to pay his expenses in attending our conventions, that salary to be fixed by the executive committee.

This motion was unanimously and tumultuously carried by a rising vote, with cries of "Speech, Speech!!"

Mr. S. F. Patterson.—Mr. President and friends. This is pleasant, but exceedingly embarrassing, for me. I appreciate and accept your cordial remarks and love for me as being true and genuine, and I am rather proud to know that I have been worthy to carry this endearing name of "Deacon," which is very dear to me, and I hope that you will all continue to call me "Deacon" and never say Mister; it is a little too stiff.

I have enjoyed my connection with the association very much. It has always been a pleasure to me to do my work, and I have tried to do the best I knew how. Mr. Andrews very pleasantly remarked on my first connection with the association. I remember it as well as yesterday. I went to Cincinnati, and it happened that at that time of the year it was the anniversary of my marriage, so that this trip was a kind of a second honeymoon. It was only the second year after my marriage and, of course, I had my best trousers on. They first named me "The Preacher," and afterwards changed it to "The Deacon."

I did not dream of any further office. I considered that my duties would cease at this meeting, but as you have given me this honorable election I feel proud to know that you think me worthy. It was not neccessary for you to do that to secure my attendance, for it was my intention, as long as I could get passes, to attend these meetings regularly. I thank you. (Applause.)

President.—If there is no further business I suppose a motion to adjourn is in order.

Mr. S. F. Patterson.—I want to say that I hope the members will brace up our new secretary and assist him as well as they have me, and make him a "deacon" or even a preacher. I know that he will fill the bill to perfection, and I trust and hope that you will give him all the assistance necessary, and that he will do even better than I have done.

Mr. Reid.—As our new secretary has done a good deal of

work this year I feel that there should be some action taken by the executive committee to compensate him a little for the work he has done, and I make that in the form of a motion.

Mr. Andrews.—I second that motion. Carried.

President Lemond.—Gentlemen, there will be a meeting of the executive committee immediately after our adjournment.

Mr. Andrews.—I move that we adjourn.

Mr. A. S. Markley.—I second that motion.

Motion was carried and adjournment taken to the third Tuesday in October, 1910, at Fort Worth, Texas.

P. B. Ransom,
Stenographer.

C. A. Lichty,
Secretary.

COMMITTEE REPORTS

FOR 1908 AND 19109

I.

VARIOUS METHODS OF CARRYING ELECTRIC TRANSMISSION WIRES OVER RAILWAY TRACKS, AND BEST WAY TO PROTECT TRACKS AND COMPANY WIRES.

REPORT OF COMMITTEE.

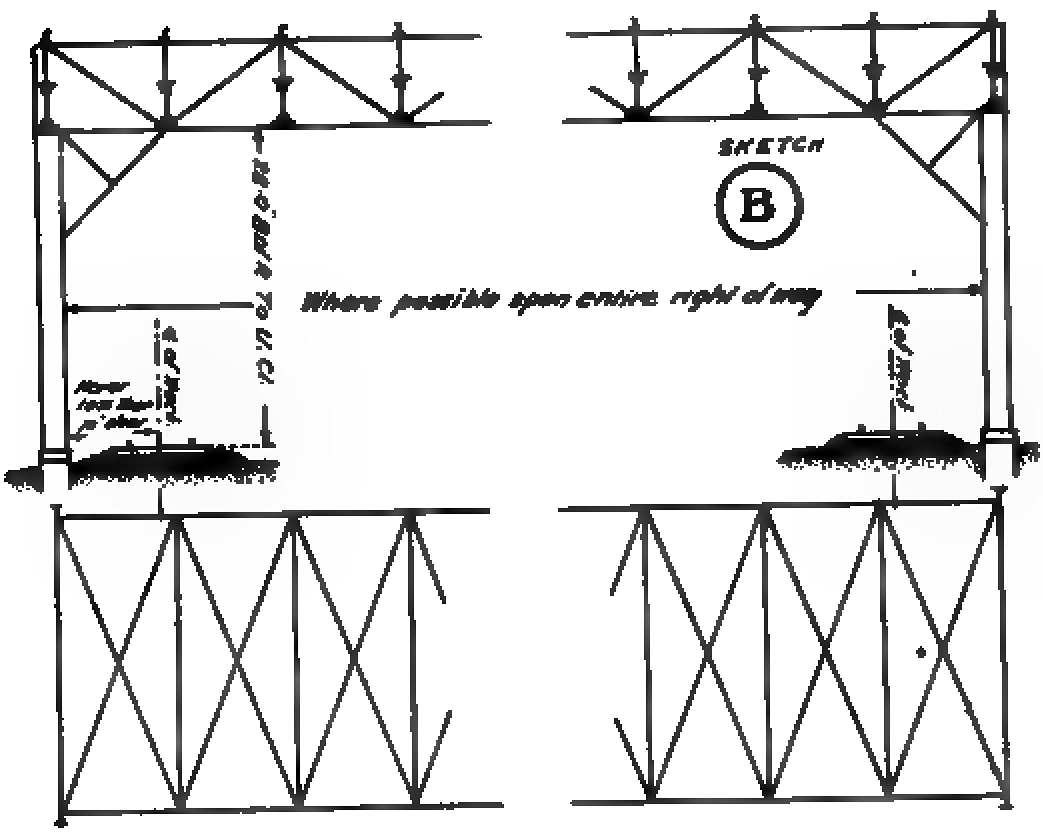
To the American Railway Bridge and Building Association:

It is generally understood that those employed in the bridge and building, and engineering departments of railroads have had but little or no experience in electrical transmission, as it is practically a new branch of engineering and there are few, in fact, who have been able to cope with the question. We understand that the American Society of Civil Engineers has had this question before its meetings at various times, but has been unable to solve the problem in a satisfactory manner.

Some of the most eminent electrical and civil engineers in the country have decided that it is not necessary to protect high tension transmission wires which cross railroad tracks by use of either the cradle, bridge or messenger wire, provided the transmission cable is strongly designed. The cables in use at the present time are very strong, mostly composed of 7-strand aluminum, being much lighter than copper; some copper is used, and some copper-covered steel, but aluminum seems to be the favorite wire with most transmission companies.

All modern crossing spans are supported by strong, well designed steel towers, or "A" frames or wooden poles. The towers are designed to withstand all strains caused by weight, wind pressure, etc., and the cables are also designed to carry their own weight, ice loads, wind pressure, etc. In fact, every device is used and every precaution taken to make the carrying of high tension lines over railway right of way absolutely safe. Some of the brightest minds in the electrical engineering field have made this their special study,

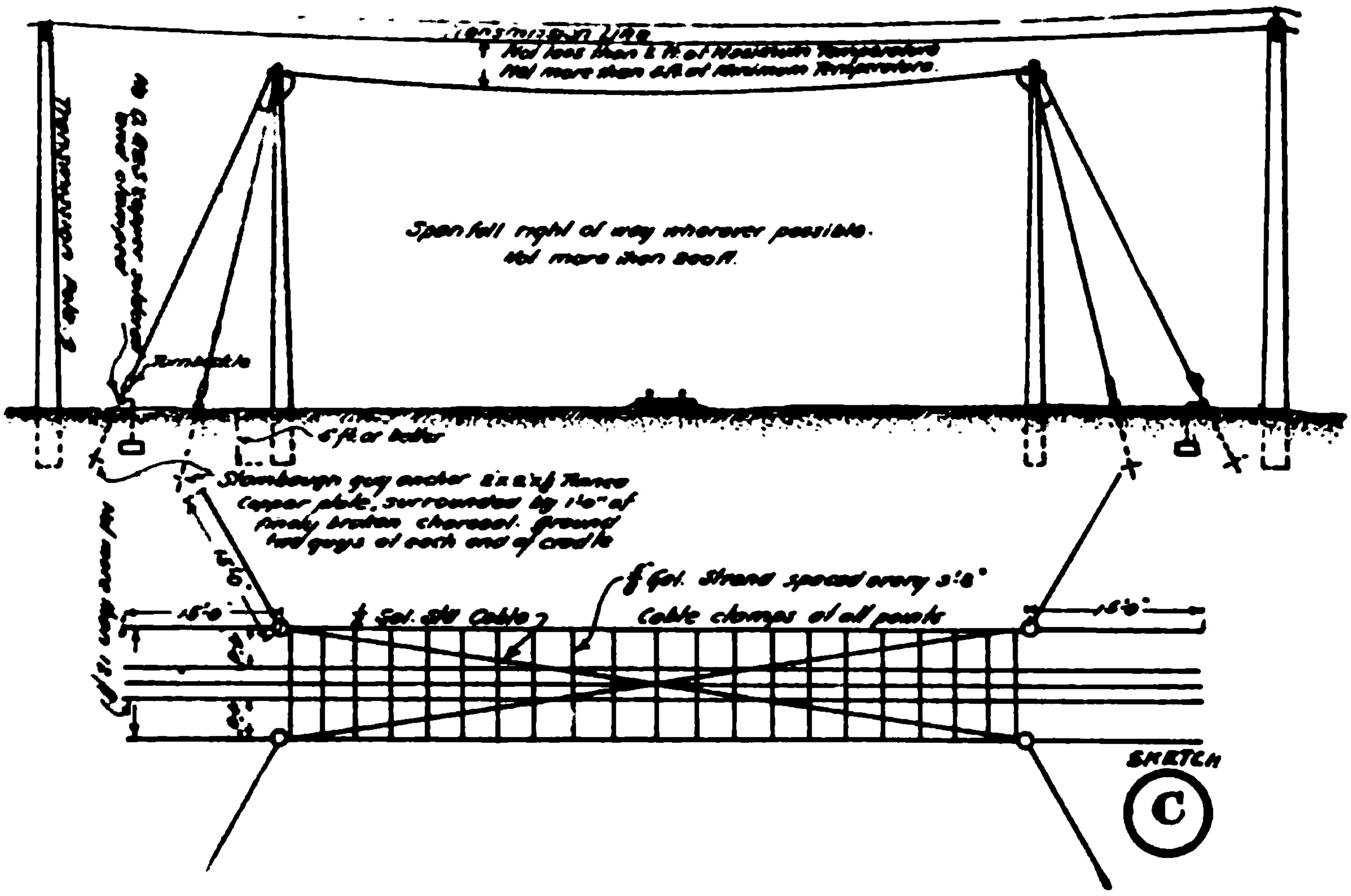
Standard Underground Crossing N. Y. C. & H. R. R. R.



Standard Overhead Bridge for High Tension Cables, N. Y. C. & H. R. R. R.

and they all agree that the simplest method is the most practicable, and experience has taught them that is is the safest.

I will attach a few sketches showing New York Central & Hudson River R. R. standards for protection. The one marked A, showing underground crossing (used for voltage 11,000 and under), does not meet with favor on account of liability to ground current. For voltage over 11,000, the aerial form of construction is necessary. At first the bridge type of construction, shown in sketch B, was extensively used, but on account of being expensive, as well as forming an obstruction at certain points to distant signals located on overhead bridges, very few were erected on the New York Central lines. Class C, commonly known as the "cradle," was adopted after the bridge plan had been given a trial. It is a cum-



Standard Overhead Crossing, High Tension Cables, N. Y. C. & H. R. R. R.

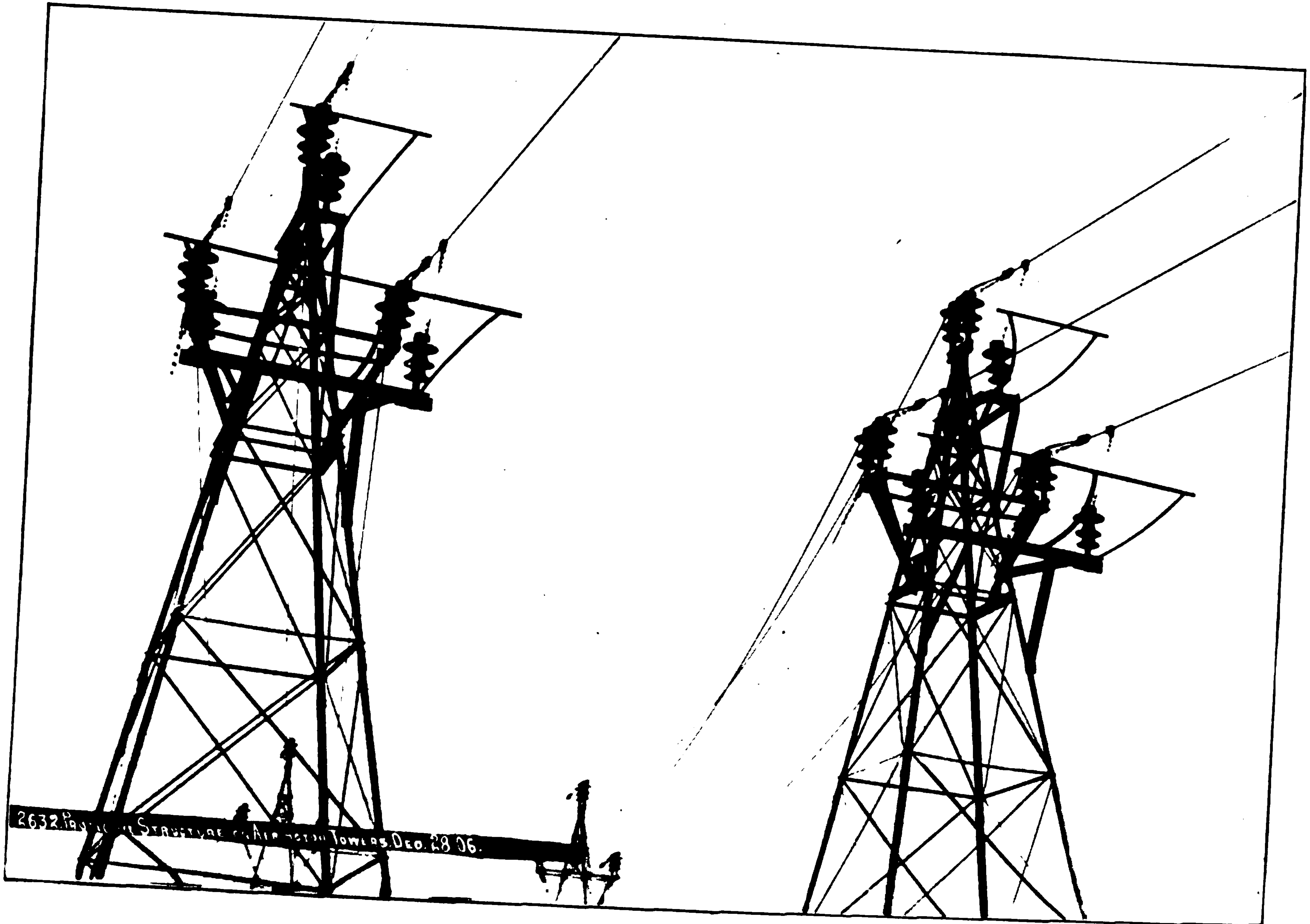
bersome, unsightly affair, and is really a menace to safety in this section of the country, where we are subject to severe sleet and snow storms, as they are liable to accumulate a very heavy load and fall.

Mr. F. H. B. Paine, general manger of the Niagara, Lockport & Ontario Power Co., has kindly furnished us with the accompanying photographs, of transmission lines in this section of the state. Mr. Paine is considered authority on everything pertaining to high power transmission lines, and I asked him to give me his views in regard to the subject under discussion, in writing, which follows:

"Like other things in engineering, the simplest is the best, and devices of every kind and description applied to the transmission line, in order to satisfy the ignorance of those not familiar with this branch of engineering, is a mistake, and I therefore commend

Transmission Lines of the Niagara, Lockport & Ontario Power Co., over Erie R R

Transmission Lines over N. Y. C. & H. R. R. R. Tracks.



Transmission Lines on Aermotor Towers. Showing Grab Wires.

Transmission Lines, Showing Abandoned Cradle, N. Y. C. & H. R. R. R.

Transmission Lines, Showing "A" Frames of Wooden Poles, N. Y. C. & H. R. R. R.

Transmission Lines, Wooden Poles, over Tracks of West Shore R. R..

to your attention as the best crossing, the one over the Erie R. R., the first of the series of photographs, which consists of our ordinary transmission line structures, just such as we use at the end of every tangent to take up dead end strains, that is all. The onlv lines that we have ever had fall upon railroads were those provided with protective devices, the failure being incident to the use of these devices.

"Our transmission lines cover a great many hundred miles, across all sorts of things and people, and I think it will be obvious at once that the form of construction crossed by the transmission line most liable to be injured by the transmission line would be the telephone systems, reaching, as they do, not only company switchboards, but also coming in intimate contact with the public. The requirements of the American Telephone & Telegraph Company simply provide that the transmission lines where they cross telephone lines shall be of the best construction that electrical engineering knows of, and nothing else.

"The organization most interested in keeping its wires up is the transmission company. Proper line construction consists of the supports, such as poles or towers, being amply strong for the strains which they must bear, assuming the highest winds, cold weather, sleet, etc., and the cables must be of sufficient strength to withstand the same strains, for it is through the cables that the strain is transmitted to the supports.

"This company always uses a standard cable, not only for railway crossings, but for all of its line construction, and our smallest copper wire is number 4, B. & S. gage, 7 strand, although I can see no objection to the use of number 6, B. & S. gage. We use aluminum as well as copper, and for manufacturing reasons, it is desirable not to go below number 1, B. & S. 7 strand.

"With reasonable provision for mechanical strength incident to the winds and ice loads above referred to, one may safely trust the electrical features, such as the form of insulation, etc., to the transmission company, whose interests are most involved.

"Where transmission wires are not covered with insulation you need not fear breakage except at the point of support. Since we have been in operation, we have had a number of instances where a wire has broken at the point of support, due to a number of causes. No harm has ever been done by any such breakage, and we have recently had a wire carrying 60,000 volts, operating a railroad nearly 90 miles long, which fell across a telephone line, to which there were probably six or seven telephones at that time connected, and the total injury to the telephone system was an injury, but not complete destruction, of two telephones.

"When your associates are as familiar with the transmission work as they are with structures, buildings, bridges, etc., they will realize that what they are trying to guard against at this moment, are ghosts, and nothing else."

Mr. Ralph D. Mershon, chief engineer of the Niagara, Lockport & Ontario Power Co., writes as follows in the Railroad Gazette of Feb. 7, 1908:

The rapid increase in the number of electric transmission lines and the distributing circuits therefrom, is rendering every day more important and more perplexing the question so frequently encoun-

tered as to the protection, if any, which should be provided at railroad crossings.

The fear which the steam railroad operator has in regard to such crossings arises from two sources. He fears the damage which might result through mechanical agencies, in case the transmission line should fall upon the track. He fears, also, the damage which he thinks might result through electrical agencies. The fear of the electric current is usually the greater, probably because of the fact that most steam railroad operators have had little, if any, experience with electricity, and they attach to it more or less of the mysterious dread which people have for it generally.

The protection for which the railroad men generally ask is a steel bridge constructed underneath the transmission line for that portion of its length which is across the railroad company's right-of-way; or at least for that portion of its length which is across the tracks. In some cases, it has been required that the transmission line be carried on insulators attached to this structure; such a requirement is an undesirable one from every standpoint.

There can be no question that a transmission line can be made as strong as any steel protecting bridge that can be installed, and, in general, strength can be obtained at a great deal less expense than is involved in installation of the bridge. A simple span of wire or cable supported at each side of the right-of-way, on steel structures if necessary, can be made as strong, both as to supporting structures and as to the cables, as any bridge which can be erected. It seems foolish, therefore, to insist upon the installation of a bridge below a transmission line for fear that, through mechanical agencies, the transmission line may be thrown down.

Probably no railroad manager would make special objection to have built across his tracks a construction similar to that of a well designed transmission line, if he knew no current was to be put upon it; but, in some instances, the mere idea of having current on the wires seems to introduce immediately a fear of the construction—both mechanically and electrically. In such cases, the ultimate source of the fear and objection to the transmission line crossings may be said to lie in the fact that the lines carry an electric current; and it is well, therefore, to examine into the possible ways in which the existence of an electric current on the lines may affect the safety of the property or employees of the railroad.

Assume a crossing with the same side clearance, overhead clearance and factor of safety as would be allowed in the case of a bridge. Assume that there is no electric current on the wires. Under such conditions, no damage except such as is equally likely in the case of a bridge can result to the property or employees of the railroad company.

Now assume that the electric current is put on the crossing. The added possibilities of danger are as follows:

(1) The possibility of overhead contact either direct or through some conducting object.

(2) The presence of the electric current in case the structure is thrown down by a train wreck, by wind, or other mechanical forces.

(3) The possible effect of the electric current in causing the line wires to fall.

The probability of (1) overhead contact can be indefinitely reduced by increasing the overhead clearance, if such clearance as would be allowed for a bridge is not considered a sufficient insurance.

The probability of (2) can, so far as wrecks are concerned, be indefinitely reduced by sufficient overhead and side clearance; and, so far as wind or other forces are concerned, by proper design and construction with reference to ice and wind loads. The practice in these matters in the case of bridges would seem to be amply sufficient, especially in view of the fact that, as mentioned later on, in a well designed and properly operated transmission system, anything which would cause the line wires to be thrown down, would cause the power to be cut off by reason of the resulting short circuit.

The question, therefore, finally resolves itself into an examination of (3) the effect which the presence of the electric current might have in causing the line wires to fall upon the tracks.

The only conceivable way in which the presence of the electric current could be the cause of the contingency mentioned is that of the establishment of an arc which should burn off one or more of the line wires. Such an arc might be established between two or more of the line wires, or between one or more of the wires and the structure supporting the transmission line. An arc between a line wire and the supporting structure could occur only in case the structure is metal, or in case the insulators are supported upon metal pins connected to each other or to ground.

An arc between the line wires, if it be instituted at a point distant from the supporting structures, can hardly be conceived of as due to anything other than the swinging together of the wires, or to their having thrown across them, either maliciously or by accident, some conducting object. The chance for an arc to be started by the wires swinging together can be removed entirely by putting them sufficiently far apart. The chance for an arc to be established by something being thrown across the line wires can be made very small by recourse to the same expedient.

The occurrence of an arc between one or more of the line wires and the insulator pins or the steel structures carrying them, might be due to a direct puncture of the insulator by electrical means, or to breakage of the insulator by mechanical means, or to the establishment of an arc around the insulator to the pin by an initial creepage of current over the insulator surface, when the insulating value of such surface had been reduced by a film of moisture, dirt or other conducting or semi-conducting substance. It should be noted that the first and last of the three possible causes mentioned would be extremely unlikely except in the case of high voltage lines, and, even then, not at all likely, if the insulator be well designed, except in the case of lightning.

In the case of the occurrence of an arc from any of the causes mentioned, the arc would not, with a properly designed transmission system, exist for any considerable portion of time, since its occurrence would cause the automatic circuit breaking appliances in the generating station to operate, thus opening the circuit and stopping the arc. The damage which such an arc could do toward burning a line wire asunder, or otherwise damaging the crossing, would depend upon the amount of power behind the arc, the length

of time it lasted, and the size or mass of the metal from which the arc was drawn. That is to say, it would depend upon the amount of heat generated in the arc tending to melt the wire or other metal concerned, and the amount of metal there was present to conduct away and absorb this heat, and thus diminish the melting action of the arc. The size and weight of the wires and other metal parts involved could be so proportioned relative to the destructive potency of any arc which might be formed that they would easily withstand the melting action, without being burned off, until such time as the automatic protective devices at the generating station opened and the arc ceased.

It would even be possible to make such provision that, in case an arc formed, it would rupture itself, even if the automatic protective devices at the generating station did not operate; and so that it would rupture itself before any serious damage to the crossing could occur. To accomplish this, it would be necessary to properly proportion not only the metal parts, but also the distances separating those parts between which an arc could occur; that is, the distances between the line cables and between the line cables and the supporting structures. Such proportioning should be done with reference to the voltage and power capacity of the transmission system: the greater the voltage, the greater the distances; and the less the power capacity of the system, the lighter could be the metal parts.

It would appear, therefore, perfectly possible to design a transmission line crossing so that it could not constitute a source of danger from either a mechanical or electrical standpoint. Such a crossing would preferably be one along the following lines:

(a) It should be so constructed that the line conductors (line wires or cables) and the supporting structures at each side of the track would be of proper strength to withstand the ice and wind loads which might come upon them. It should be self-sustaining; that is, should be capable of standing up under the action of wind and ice without reference to the remainder of the line, so that the line, on one or both sides of the crossing, might break without interfering with the crossing itself.

(b) There should be sufficient overhead clearance between the line and the track, so that there would be no possibility of contact except by deliberate intent.

(c) The line conductors should be far enough apart so that they could not swing together.

(d) The line conductors should be sufficiently massive so that an arc might exist between them for several seconds, without danger of burning or melting them off.

(e) If the supporting structures are of steel, or the insulator pins are of metal and the pins connected to each other, or to ground, the insulators should have cast metal caps cemented upon them. These caps, or extensions of them, should extend out on each side of the insulator for some distance along and underneath the conductor, in order to further protect the conductor, or else the conductors should have, in addition to the caps, a protection from arcs in the form of a serving of wire upon them for some distance on each side of the insulator. The result of such protection will be that an arc formed near the insulator will expend itself upon

the serving wire, or metal casting, instead of upon the conductor itself.

It is not to be understood from the above that a crossing would necessarily consist of a single span. It might consist of a series of spans, meeting the above requirements, where several spans were necessary for crossing a number of tracks, such as would be found in a railroad yard.

A crossing constructed on the above lines would be as safe as any reasonable individual could ask, and at the same time would be a great deal cheaper than the steel bridges sometimes insisted upon.

The matter of steel protective bridges is a very serious one to the transmission companies, not only on the score of expense of the bridges themselves, but because of the difficulty often met in installing them or getting permission to install them, especially when they are required in towns and are objected to by the municipality. If they are insisted upon, it will greatly retard the development of those sections of the country fortunate enough to be within electric reach of cheaply generated power, since the requirement of a bridge for a railroad crossing will, in many cases, prohibit the supplying of small customers with power. This, of itself, is a matter of importance to the railroads in that on the welfare and progress of the community depend the amount of, and increase in, the railroad company's revenue, but there is an aspect of the question aside from this which should be the subject of much thought by railroad men. The time is undoubtedly near at hand when all of the principal railroads of the country will equip a portion at least of their lines for electric traction. If this is done, the railroads cannot hope to be free from the necessity of carrying their line conductors across not only their own rights-of-way, but the rights-of-way of other roads. If the railroad men now insist upon the elaborate means of protection which have been insisted upon in some cases, and crystallize public opinion to the idea that such elaborate protection is necessary, they themselves will be confronted with the necessity of making use of the elaborate and expensive protection in question.

It behooves the railroad man, therefore, to consider this matter of crossings very carefully and with the utmost spirit of fairness, since in so doing he will not merely serve the interests of the transmission companies, but also the interests of his own and other railroad companies in the future.

Edward J. Govern, Civil Engineer, Rochester, N. Y.:

I am enabled to add very little to the information already given in the report, and in further comment relative to the question placed before this committee, I feel that it is not a fair question to be brought before the members of this society for investigation and report, as it requires the knowledge and experience of our best electrical experts who are today engaged in the study of this matter, and any report that we might formulate without securing the advice from electrical experts, or those handling the present question, might be valueless, as this is purely the day of observation of this question. Some of the members of the American Society of Civil Engineers have taken up the question of electric transmission and overhead construction work, and papers and discussions bearing on

the same may be found in Vol. 60, of June, 1908, of their proceedings. I believe that members interested in this important work would do well to consult these papers, and no doubt would gain some valuable information from the same.

After investigating the various papers and reports covering this question, it is evident that it is in the experimental stage, and that no attempt at present can be made toward standardization of overhead crossings. Whatever might be done in this line at present may become obsolete before the end of the year.

W. A. Pettis,
Chairman.

DISCUSSION.

President.—This is a subject on which it is very difficult for members of our association to make up a report, as we have not much experience along electrical lines, but on reading over the report which has been gotten up by Mr. W. A. Pettis, the chairman of this committee, it would seem that he has gotten as much out of the subject as is possible. If there is any member here who has had experience on this question we will be very glad to hear from him.

Mr. Lichty.—I think that the experience of the New York Central & Hudson River R. R., as shown in this report, contains the gist of this subject. They went to considerable expense to prevent high-voltage wires from doing damage if they fell on the tracks, by reason of high winds or heavy sleet, and in most cases the arrangements which they provided for this purpose caused more damage than the wires themselves, and they secured better results by simply using a good quality of wires and putting them up properly, than by using the old-style cradle or other protective devices.

Mr. Sheldon.—The subject is certainly a "live" one in more senses than one, and I think that most of our members will keep as far away from it as possible. Seriously, I think the wires should be arranged so that in case of a break a fuse will be blown out and thus make the wire dead. We merely put our wires up as high and as strongly as possible.

President.—Of course we must all admit that this is a subject that we are not very well prepared to talk upon. The report is a very interesting one, however.

Mr. Hadwen.—It appears to me that the position taken in this report is a good one, the recommendation being that no protection be made other than by strongly supporting and strengthening the transmission lines themselves.

Mr. Fullem.—The subject has not come up on the Illinois Central R. R., recently, but our experience was the same as that reported on the New York Central R. R.

Mr. Sheldon.—The only thing further that I would like to say is that in many cases where high voltage wires cross our tracks we require a bridge, made usually of cables, across which are placed pieces of wood, or slats, so that in case of breakage of the wire it drops onto this and does not strike the ground. The breaking of a wire in all cases with us blows out a fuse and makes the wire dead. In some places netting is used so that in no case will the wire drop to the ground.

Mr. Aldrich.—On our road we have considerable territory on which the trolley is run over our steam lines and we have no protection at all, further than if the wires crossed a street.

Mr. Reid.—I have read the report, and while the statements given there are by men who are interested in power production and transmission lines, primarily, and it might be claimed that naturally they would present their own interests first, yet when you analyze their statements and go into the report it looks to me as though they know what they were talking about. The more one considers it the better their arguments appear, and the less reason there appears for any special protection under these high voltage wires. They are the parties primarily interested, and if an accident happened they are the first to suffer. It seems to me that the tendency is toward more perfect construction of the wires themselves and less special protection underneath.

II.

INSPECTION OF BRIDGES AND BUILDINGS.

REPORT OF COMMITTEE.

To the American Railway Bridge and Building Association:

The committee sent out 64 letters asking for information on the subject and received 30 replies. Some very good information was received in this way and the committee desires to express its appreciation of the assistance rendered. Extracts from some of the letters are given at the end of this report.

As stated in the subject, this report has to do both with the inspection of bridges and buildings.

INSPECTION OF BUILDINGS.

Very little information was received as to the method of inspection of buildings. The primary object of a railway plant is to produce transportation and the maintenance of bridges is more essential for this than is the maintenance of buildings. Hence the inspection of buildings does not get as much consideration as does the inspection of bridges. Wherever there is a railroad building there is a railroad employee to use it and he will note and report any necessary repairs or defects, if for no other reason than for his own convenience.

The bridge foreman is in and around the buildings in his district quite often and if he does the building work he will report the needed repairs from time to time.

On the usual building inspection tour the idea of rebuilding is seldom brought up. Even though a building is old, it can be repaired and will still serve its purpose just as well as any new building of the same type and size. The more important buildings are rebuilt in order to accommodate a larger volume of business than the old one was designed for, hence the new one is larger and better than the old one. In other words, buildings are inspected for maintenance of the present structure rather than for the necessity of rebuilding.

On some roads the building inspection is made at the same time as the annual bridge inspection. This system is all right where the buildings and bridges are maintained by the same department, but where the two departments are separate such a plan need not be followed, and each inspection can just as well be made independent of the other. Quite often there is not time to make building inspections while the bridge inspection is being made.

The division official in charge of the maintenance of buildings has sufficient opportunities to make inspection of buildings at different times during the year, while going over the road on other business than that of inspection. This, with the information sent in by the building foreman and the employees using the buildings, seems sufficient for building inspection.

Owing to the many different conditions at the various buildings, no practicable form can be made for inspection notes. An ordinary leather-bound field book would serve this purpose very well. Size of this book should be about 4½x7 inches, containing 100 leaves. To facilitate the making of sketches, the pages should have cross section ruling, the lines being spaced about 1-7 of an inch apart in both directions.

INSPECTION OF BRIDGES.

This subject has been treated quite extensively in the past by this Association and by the American Railway Engineering and Maintenance of Way Association. The proceedings of the thirteenth annual convention of this Association and volumes 5, 8 and 9 of the American Railway Engineering and Maintenance of Way Association contain reports on this subject. The report in volume 5 of the M. of W. Association is devoted to forms and blanks, for bridge inspection reports. Those in volumes 8 and 9 are devoted to methods of making inspections.

Bridge inspections can be classified into three kinds—current, general, and special inspections.

CURRENT INSPECTIONS.

1. The section foreman while making his daily track inspection should also stop and examine all bridges and culverts. The object is to discover any broken or damaged parts which might have developed during the past 24 hours, due to storms, fires, derailments, etc. No report need be made of this inspection unless something is found which impairs the safety of the bridge.

2. The bridge foreman should make bi-monthly inspection of all the bridges and culverts in his district. In this way he can keep in touch with the condition of the bridges and plan his work so as to do first that which is most needed. Owing to floods, derailments, fires or other causes which may have slightly damaged a bridge, it becomes necessary to make repairs not included in the yearly list of repairs. Such cases should be reported to the bridge foreman.

An ordinary blank book of convenient pocket size can be used for making notes on the inspection. Every night a report should be made out for each bridge inspected during that day. The current bridge inspection report used by the Central Railroad of New Jersey is very good for this purpose. It is practically the same as the form M. W. 1005 recommended by the M. of W. Association.

3. Reports from the foregoing current inspections will be received from time to time by the division foreman or supervisor. These will indicate to him which bridges need attention; he should then make inspection of such bridges and decide what shall be done to keep them in safe condition, making a report of the work necessary to his immediate superior, and he, in turn to the general official in charge of the maintenance of bridges. It would be of no advantage to use any special form for these reports and they should be made by letter.

GENERAL BRIDGE INSPECTION.

This might also be called the annual bridge inspection. It should be made annually and during this inspection all recommendations for repairs and renewals for the following year should be made. There should be on this inspection the general bridge inspector, division foreman, or superior, and the district foreman.

The general bridge inspector acts as a representative of the chief engineer and the engineer of bridges. He receives direct instructions from these men and should carry out their ideas in making recommendations. This will also tend to give uniformity to the maintenance of bridges over the entire system.

The division foreman and the district foreman know the local conditions at each bridge, which are very important in determining what repairs should be made, or if the bridge should be rebuilt. The current of a stream may have some peculiar action and in case of a pile bridge there may be some difficulty in keeping it in line, or perhaps the bridge heaves in winter. These, and many other defects, cannot be discovered by an inspector going over the road, unless he happens to arrive at one of this class of bridges just when such defects are apparent.

The chief engineer or the bridge engineer may desire to investigate personally the more important items of rebuilding, in which case another inspection will be made by one or both of these men, accompanied by the bridge inspector who will be prepared to give his reasons for the recommendation.

There should be a sufficient number of general bridge inspectors so that the entire system can be gone over during the time from May 1, to October 31. This applies to the roads in the north; in the south where the climate is favorable for bridge inspection the entire year the above time limits need not apply.

The notes of the general inspector should be kept in a book made for this purpose. Such books, samples of which were received by the committee, can be divided into three classes, noted below as A, B and C.

A. On one page the bridge number, class, length, number of repairs and height of four or five bridges is given in vertical columns at the top of the page. Just below this, on the same page, the different items which are to be considered at each bridge are indicated by means of horizontal headings. The opposite page has horizontal and vertical lines so that each pile, stringer or other part of a bridge will have a definite square in which its conditions can be noted. There is generally some code for making notes in such books.

The book used by the Oregon Short Line R. R. is an example of this class.

B. One page is the same as in class A, it being the page bearing the number and description of four or five bridges and the items to be considered. The other page is blank, except for the horizontal lines, to be used in making notes.

The book used by the Chicago and North Western Ry. is an example of this class.

C. The bridge number, class, length and height are given on one page, in a horizontal line. The other page has only horizontal lines or is divided into two vertical columns, one for the recommendation and the other for the bill of material.

Size of Page 4" x 9"

Number of Bent.	NUMBER OF PILE						Cap.	Spans.	Height.
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.			

Horizontal Lines 5/32" apart

Left Hand Page of Bridge Inspection Book.
Oregon Short Line R. R.

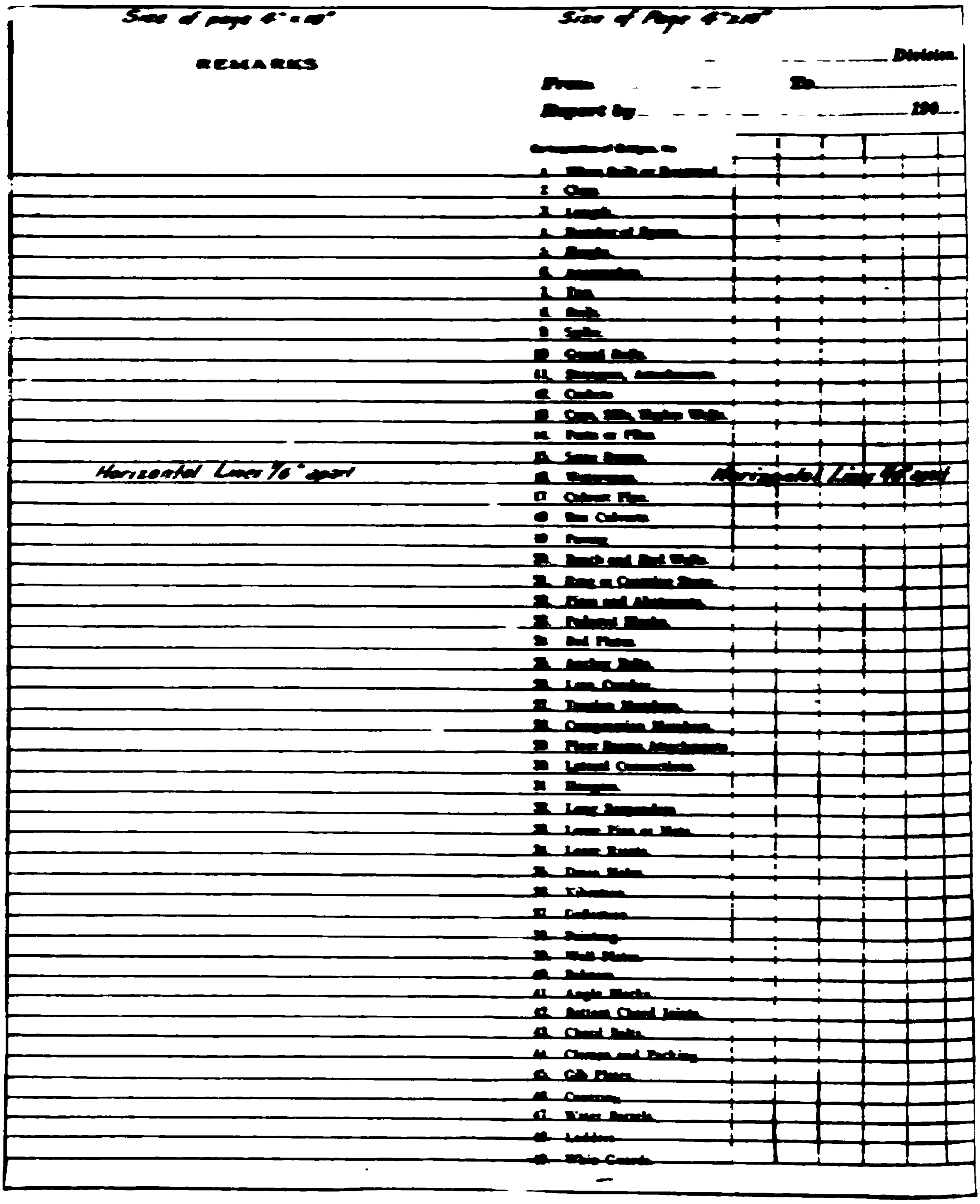
O. S. L. R. R. .... DIVISION

FROM .... TO ....

REPORT BY .... 190 ..

On Inspection of Bridges No.						
1. Class of Structure						
2. Length						
3. Openings or spans						
4. Height to base of rail						
5. Approaches						
6. Ties						
7. Rails						
8. Spike						
9. Guard Rails						
10. Stringers, Attachments						
11. Corbels						
12. Caps, Sills, Timber Walls	Hori	zon	tal	Lines	5/64	" apart
13. Posts or Piles						
14. Sway Braces						
15. Waterway						
16. Culvert Pipe						
17. Box Culverts						
18. Paving						
19. Bench and End Walls						
20. Ring and Covering Stone						
21. Piers and Abutments						
22. Pedestal Blocks						
23. Bed Plates						
24. Anchor Bolts						
25. Line, Camber						
26. Tension Members						
27. Compression Members						
28. Floor Beams Attachm'ts						
29. Lateral Connections						
30. Hangers						
31. Long Suspenders						
32. Loose Pins or Nuts						
33. Loose Rivets						
34. Drain Holes						
35. Vibration						
36. Deflection						
37. Painting						
38. Wall Plates						
39. Bolsters						
40. Angle Blocks						
41. Bottom Chord Joints						
42. Chord Bolts						
43. Clamps and Packing						
44. Gib Plates						
45. Covering						
46. Water Barrels						
47. Ladders.						

Right Hand Page of Bridge Inspection Book.
Oregon Short Line R. R.



Chicago & Northwestern Ry. Bridge Inspection Book. (These sheets folded in the middle and bound, giving all blank spaces for notes on left hand page.)

Size of page 5" x 8"

Bridge No.	KIND (Pile, Trestle or Truss)	LENGTH	HEIGHT	Date Inspected
	Hor. Lines	1/4" apart		

Left Hand Page of Bridge Inspection Book.
Atchison, Topeka & Santa Fe Ry.

Condition of Bridge and Description of Work to be Done	MATERIAL REQUIRED

Right Hand Page of Bridge Inspection Book.
Atchison, Topeka & Santa Fe Ry.

The book used by the Santa Fe is an example of this class.

In the front part of all of these books instructions are given for making inspections.

Owing to the various types of bridges and culverts, and the different conditions found at each one, it is impossible to devise a ruled form for all cases by means of which notes can be made by filling in spaces and squares. Nor is it possible to devise a list of items to be examined which will apply to all types and conditions of bridges.

In the front of each book there should be instructions for making inspections. These will indicate in a general way how the notes are to be written and what is necessary in order to make a good inspection. On each page of the book there should be spaces for the general characteristics of the bridges, such as number, date, class, length and height; the remainder of the page should be left blank for the inspection notes. Each page should also have a heading showing the name of the division, date, name of the inspector and the stations between which the bridges on that page are. This form of a book will allow considerable freedom and such notes can be made as will apply to the bridge under consideration.

The committee received numerous forms on which reports of general bridge inspections are made. Some of these forms are very elaborate, being divided into many columns, so that there is a small square for noting the condition of each part of the structure. The main part of the report is the recommendation for repairs or renewals and the largest part of the sheet should be devoted to this purpose, a small space being left for the bridge number, age, length and such general characteristics. In fact, there need be no special form for this report. In such case, instructions should be issued explaining how it should be made.

SPECIAL INSPECTIONS.

The general bridge inspector should have about five months of the year in which to make special inspections. In the northern country it is well to have this time in the winter, when he can get under the bridges on the ice. Another good time for special inspection is while a bridge is being painted, because then the inspector can use the staging swung by the painters.

These inspections are to include all the large bridges, especially the older ones, the object being to spend considerable time on each bridge and a very thorough inspection made. During the annual inspection all bridges should be noted that need such inspection.

Notes for these inspections should be kept in a leather-bound field book. All of the pages should be ruled, vertically and horizontally, so as to form square spaces 1-7 of an inch on a side. This ruling will aid in making sketches which are quite often necessary on these inspections.

Reports of these inspections can be written on a blank sheet, no special form being necessary.

LEE JUTTON,
H. H. EGGLESTON,
F. O. DRAPER,
HENRY BENDER,
Committee.

APPENDIX.

H. R. Leonard, Pennsylvania R. R.:

Divisional inspections are made every three months by the division engineer and master carpenter, and in addition, on important divisions and certain structures, special inspectors are at work all the time. Reports are made on a division blank which I do not feel at liberty to send you, as it has not been thoroughly tried out. Annual inspections are made by the engineer maintenance of way and his assistants, on which inspections all bridges marked for repairs or renewal are examined. Should there be any question as to the advisablity of renewal or repairs, the engineer maintenance of way is directed by our organization to consult with the engineer of bridges. Programs are made up every year by the division officers as to what repairs or renewals are deemed necessary. The authority for repairing or rebuilding comes from the general manager. The extent of such repairs or renewals is of course dependent upon the amount of money available.

Our organization is such that the responsibility for the carrying of existing bridges is placed with the division officers immediately in charge of them.

J. P. Snow, Boston & Maine R. R.:

Once each year an inspector detailed for the purpose visits and reports upon each bridge and open culvert on the system. We also include stone arches down to 6 ft. span.

The inspector may be an assistant from the engineering office or a practical workman. He is generally depended upon to inspect the new bridges when erected by contractors and when not otherwise employed is worked wherever his abilities best admit.

A small velocipede car weighing about 60 pounds is used for transportation. This enables a man to cover from 15 to 30 miles a day where there are no bridges of large magnitude.

I enclose an inspection blank. One of these is filled out at each structure. Before handing them in the inspector makes a copy of them or secures a copy by using carbon paper, and this copy is kept and referred to at the following inspection. I enclose also a slip of instructions that is pasted on the inside of front cover of each block of 100 blanks.

The inspector is furnished with a list of structures on each division, giving number, location and style of bridge. This is a small typewritten pocket book, designed to assist him in identifying the structures and is his order for that year's inspection. It is corrected each year in ink and whenever data are lacking pencil notes are made against the structure in question calling for the information needed.

These reports furnish not only information in regard to our bridges but are the basis upon which our reports to the various state and interstate commissions are annually made up. The inspection here described is under the direction of the bridge engineer, an adjunct of the chief engineer, while the maintenance of all structures is under the division superintendents. Each division supervisor is responsible for his structures and each one has his own method of keeping in touch with them. Some duplication of work is hence liable to occur as may be seen.

If a structure seems to the inspector to require repair or reconstruction the bridge engineer either visits it or asks the division superintendent to have it examined, and if the final verdict is for rebuilding the said superintendent applies to the general manager for authority to do the work.

As to my ideas of what constitutes an ideal system of inspection: I believe, for an organization such as ours, that the inspections should be made under the direction of the supervisor; that he should make such copies as he wants, after which he should endorse his comments on them and pass them to his superintendent, who should in turn pass them to the bridge engineer. In this way one inspection would suffice for all concerned.

I find that annual inspections are ample for my purpose except for a very few bridges which for certain reasons are not quite satisfactory.

A. S. Markley, Chicago & Eastern Illinois R. R.:

It is the custom on this road to make two inspections annually on motor car, in the months of May and September, the former inspection being used as the basis for the year's program. This inspection is made in the direction bridges are numbered, or from north to south, and all bents, etc., in the structures are numbered in this direction.

Before inspecting, blank leather-bound memorandum books four inches wide and seven inches long, each containing one hundred pages, are prepared for this purpose. On the left hand page is written the number of the bridge, location by telegraph pole number and a short description, stating whether the opening is iron or sewer pipe, pile or frame trestle, etc., and giving size, length, height dimensions of timbers, date last renewed, etc. Buildings are listed with size, description, construction and roof, etc. Public and private highways are also noted in the books. All items are written consecutively as they are passed in going over the road, and ample space is left between them for additional notes to be made during the year. On the opposite page is recorded the bill of timber for renewing or repairing the bridge, building or other structure, together with all information necessary to make up the program for the year's work and to issue instructions to men to make repairs. Additional information accumulated from time to time is noted in the inspection book, as well as all repairs, changes, renewals, etc. Foremen are instructed from these notes, but they are also given authority to renew any decayed or defective timbers found, although not noted in the book. A semi-weekly report is sent in by each foreman, stating what has been accomplished each day, the number of men and hours worked on each job, and percentage of work completed. These reports are checked against the inspection reports, and notations made in red ink on the books, of such information as is pertinent to the record, such as any changes in the size of timber or piling, date repaired or renewed, and the foreman's name making repairs. All emergency work is recorded on the books, as well as any unusual incident that might occur to the bridge, such as a washout, fire, wreck, etc., giving all details. If a structure is filled, a building destroyed or moved, it is recorded in the proper place in the inspection book. These books are rewritten each year, the latest record of the structure being used to

ccpy from. An accurate history can be recorded and traced from these books. I have these records in my office, each year's books filed separately, and can refer to them at any time.

Where repairs have not been made during the year they are noted in the inspection book the following year and added to the program if the structure requires it.

A variety of books, with pages specially ruled and spaced, for inspection purposes have been made, none of which are convenient for our purpose. No one can foretell what notes will be required to get the desired information for record, and all kinds of structures are intermingled indiscriminately on one page, not in rotation, making the specially prepared book impracticable unless it be printed in order as the structure appears on the road and being reprinted at times to include the changes.

On inspection all buildings and bridges are carefully examined, noting all repairs required on the structure. On wooden bridges, a diamond-pointed steel bar five feet long is used for testing timber, all four years old and over being prodded to determine if any should be removed. The bridge foreman of the district and one bridge man pass under the bridge on the ground; the bridge inspector and one bridge man inspect the deck, above the caps. The master carpenter and division engineer take notes and decide which material is to be repaired or renewed; all parties keep together on the bridge to insure a thorough inspection.

Iron bridges are also inspected and rivets tested just previous to painting. Intermediate inspections are made from time to time by the regular bridge inspector every three months. All notes for bridges and buildings made by him are placed on the inspection books opposite the structure requiring attention. This also applies to any notes the division engineer or master carpenter may make from time to time.

Soundings should be taken through all arches and along all piers and abutments to see if scour exists, which might endanger the foundation. Inspection is made of all iron and sewer pipes, either by looking into them from both ends or passing through those which are large enough, to see if any of the joints have pulled apart, allowing gravel or earth to run into pipe, obstructing the free flow of water. Close observation should be made at points where live loads are concentrated, where stringers rest on caps, caps on piles and posts on sills.

A. O. Cunningham, Wabash R. R.:

The foreman of each bridge gang is instructed to inspect the bridges under his charge as often as he thinks advisable, but not less than once every month. His reports go directly to the engineer maintenance of way. In addition to this inspection, there is one inspector for this entire railroad, who reports to the chief engineer, and also to the engineer maintenance of way, of the division on which the bridge he is inspecting is situated. This inspector is able to go over all steel bridges once every month. In addition to this, the engineer maintenance of way makes an inspection twice a year, and the chief engineer once a year. The section foreman inspects the track on bridges daily.

I am enclosing herewith blank form used by the inspector. No forms are used by the engineers maintenance of way, as notes are

made while their inspection is being made. If it is necessary to renew a bridge, a blank form called an "AFE" is made up by the engineer maintenance of way which is approved by the superintendent of the division, the chief engineer, the general superintendent and the general manager. On this blank the estimated cost of the bridge, in detail, is written up.

It is rather a difficult matter to outline an ideal system for bridge and building inspection, without first knowing the kind of organization. Ordinarily, when the maintenance of way department reports to the chief engineer, then one inspector should be detailed to inspect the bridges and buildings on each division, reporting directly to the supervisor of bridges, or to the division engineer. It is not necessary to inspect steel bridges oftener than once a month, and if these bridges are of late construction, twice a year is ample. In case of very light steel bridges, it may be necessary to inspect them as often as once a week. Buildings should be inspected twice yearly.

Pile trestles should be inspected directly after each heavy rain, and the track inspection made daily, in order to determine whether the ties or stringers have been endangered by fire. This latter, of course, should be done by a track inspector. One inspector to a division of about 500 miles is sufficient for ordinary western railroads, when there are a number of wooden trestles and several light steel bridges. The length of territory may be increased when there are few wooden trestles, and when the steel bridges are of late construction.

H. W. Wilkinson, Erie R. R.:

Bridges are inspected monthly by division bridge inspectors or master carpenters. Each quarterly inspection is written out on special blanks and forwarded through the general office to the engineer of bridges and buildings, for file. In addition, the engineer of bridges and buildings has two traveling inspectors who continually move over the line inspecting bridges about twice annually and reporting on no special form. Buildings, under the present system, are not subject to any special inspection, except engine houses which are reported on by the engineer of bridges and buildings. In general the buildings are taken care of by the maintenance department and inspections made as found necessary.

A new system of inspection is now being inaugurated with blanks in book form, having one page for each bridge or building. These blanks have not yet been put into use, but the expectation is that this will be done very soon. For this reason I am not sending you a copy of the forms at present in use. The number of inspections, both for bridges and buildings, will be about as outlined for bridges above.

As to steps necessary to be taken in order to get authority for rebuilding a bridge: Based on reports received and personal investigation and inspection of bridges, the engineer of bridges and buildings usually lists certain bridges recommended for renewal. These are then estimated and the tabulation submitted through the proper channels for authority, which is customarily done annually. Whenever a bridge needs renewal, which is not included in the annual list, special estimate is made and submitted through the regular channels for authority and work accomplished in that way.

Size: 8" Hor. x 13" Vert.

LEHIGH VALLEY RAILROAD ____________ DIVISION.

OFFICE OF DIVISION ENGINEER

Bridge Inspection Report for Month of ____________ 190

Bridge No. or Structure	LOCATION	Day of Month Inspected	CONDITION	Action taken or Recommendation
			Hor. lines Spaced 1/3"	

Date, ____________ *190*

____
Division Engineer.

NOTE—This report to be prepared monthly and to include all bridges and structures inspected by the Bridge Inspector during the month.
Send three copies to the Division Superintendent who will transmit one each to the Engineer Maintenance of Way and the Bridge Engineer.

With regard to my ideas as to what would constitute an ideal system of bridge and building inspection, a very good way seems to me to be that of having an inspector on each division with book form blanks for each structure, making reports monthly on the condition, the blanks having space provided for recommendations as to what should be done to keep the structure safe and what should be done to maintain the structure in good condition. Added to this, it might be well to have one or more general inspectors to move along the line and keep track of the division inspectors and handle such special cases as are called out by the regular inspections.

F. E. Schall, Lehigh Valley R. R.:

Instructions Governing the Inspection of Bridges and Trestles.

1. A bridge inspector, reporting to the master carpenter, will be assigned to each division for the proper inspection of all bridges and trestles.

2. He will make a careful inspection of each bridge and trestle on his division at least once every two months, and will also make special additional inspections of such structures which show undue vibrations or other irregularities. In making his inspections he will be governed by the general instructions to bridge inspectors issued herewith.

3. He will make a report of the inspection of each bridge and trestle on Form M. W. 49, furnished for that purpose. This report will be sent daily to the master carpenter of the division, who in turn will transmit the same to the division engineer.

4. In case of danger or urgency, he will report by telegraph to the division superintendent, the division engineer and the master carpenter, the conditions as he may find them, and take such action in the meantime as may be necessary for the safety of trains and the structure. He will follow this telegraphic report by his regular daily report as specified above. A telegraphic report will be made by the division superintendent to the engineer maintenance of way and the bridge engineer, describing the dangerous conditions which may have been found, with a statement of such action as may have been taken in the matter.

5. The bridge inspector's report will state briefly the conditions of the structures he has inspected. He will clearly state any defects or irregularities which may have developed, and if the structure is in good condition he will simply make a declaration to that effect.

6. An examination of all bridges and trestles will also be made by the division engineer on Form M. W. 50, furnished for that purpose, and sent to the division superintendent of that division, who in turn will transmit copies of such report to the engineer maintenance of way and to the bridge engineer.

7. General inspections which may be made by the bridge engineer, or his assistants, from time to time, will not relieve the division engineer, the master carpenter or the bridge inspector from any responsibility or the obligation to carry out all rules and regulations relating to the maintenance of all bridges and trestles in safe condition for the passage of trains.

8. The bridge inspector will keep the masonry and iron work at all bridge seats clear from rubbish, dirt and other objectionable material. He will at the time of the inspection of a structure adjust any loose rods, draw up loose nuts or bolts, replace bolt nuts

7-[illegible]

Form M W 40

Report No. ....

L. V. R. R. .... **Division.**

BRIDGE INSPECTOR'S REPORT.

I have to-day inspected ....

at ....

and find its condition as follows:

The following work is required to maintain structure in good condition:

Actual Size 5½" x 8½"

Lines ⅓" apart

The following work must be done to keep the structure safe:

Date, ...190 ....

Bridge Inspector.

NOTE—Make a separate report for each bridge or structure inspected. Send reports daily to the Master Carpenter of the Division. Report by telegraph to the Master Carpenter and to the Division Engineer and Superintendent all serious defects that require immediate attention

In case the condition of the structure is dangerous flag all trains and telegraph the Division Superintendent.

Bridge Inspection Report Blank, L. V. R. R.

where lost, and make such other minor repairs as can readily be done by one man without taking much time. For the adjustment of heavy rods or other work the inspector will call on the master carpenter for assistance, but in the case of emergency, draw on the nearest section or other force for assistance.

Austin Lord Bowman, J. J. Yates, Central R. R. of New Jersey:

Inspection by the M. of W. department.

1. Daily inspection by track men.

2. Examination of certain bridges at stated intervals by competent M. of W. bridge men.

Inspection by the Engineering Department.

1. Inspection of certain bridges by the bridge inspector at intervals, usually not exceeding one month.

2. Special inspection by bridge engineer of bridges requiring careful attention, renewal or extensive repairs.

3. General inspection (semi-annually) of all bridges by the bridge engineer, engineer M. of W., bridge inspector and foreman of bridges.

In addition to the above the bridge inspector is required, previous to the general inspection, to inspect all such bridges as cannot be satisfactorily examined on the general inspection on account of size of bridges and lack of time. He examines the sub- and superstructures, examines the foundations, tests rivets and bolts, and notes the action of the span under traffic. He has all this information ready so that he can answer any questions asked him on the general inspection.

Usual steps necessary to get authority to rebuild a bridge:

1. The general bridge inspection report.

2. Report and recommendation by the bridge engineer to the chief engineer.

3. Requisition by the principal assistant engineer.

4. Report and recommendation by the chief engineer to the general manager.

5. Approval by the general manager.

I enclose copies of the C. R. R. inspection report blanks. You will please note that these blanks are practically the American Railway Engineering & M. of W. Association approved forms M. W. No. 1005 and M. W. 1007.

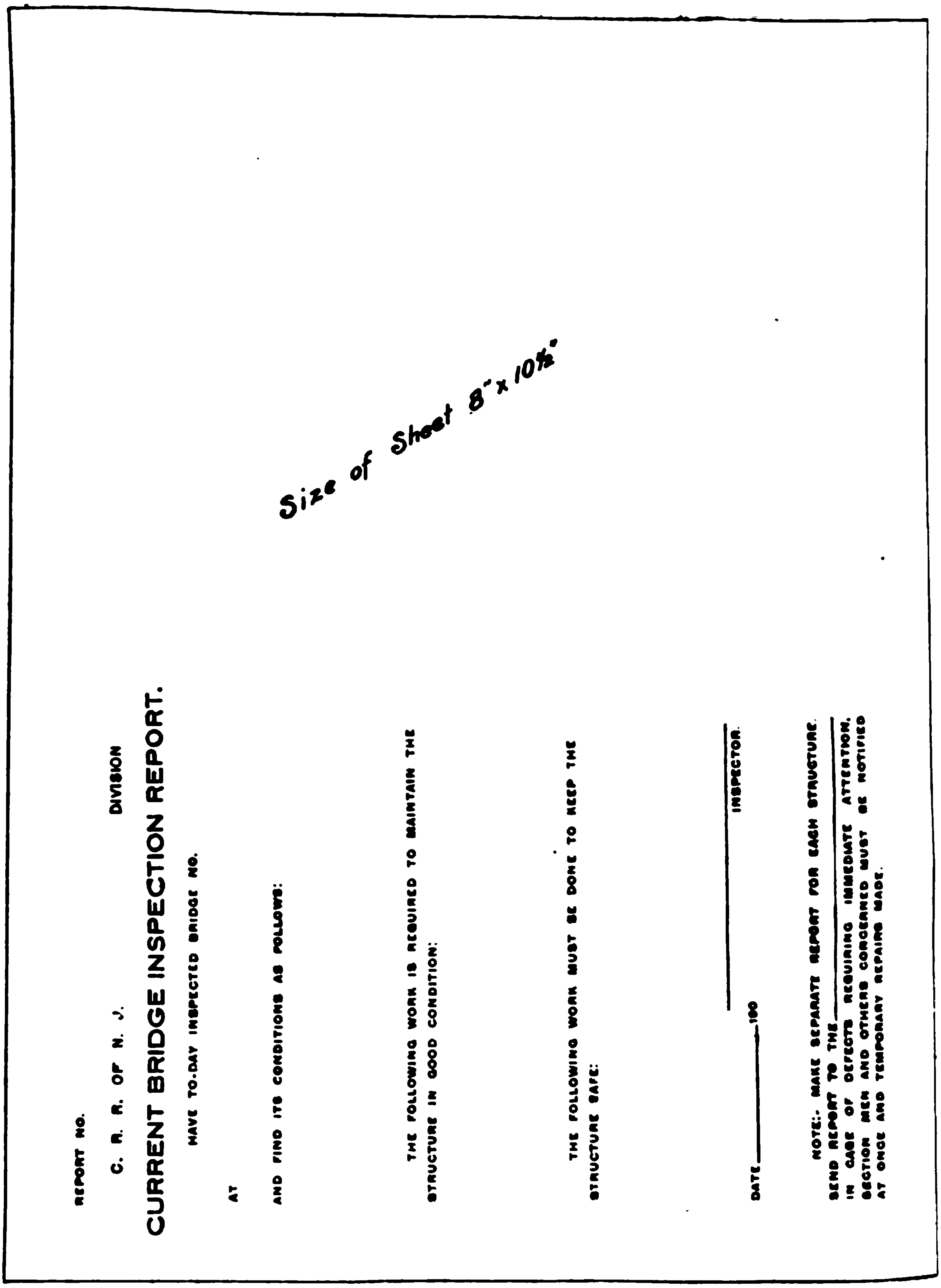
Personally, I think that with possibly slight changes to suit the organization of the different roads, the method proposed by the American Railway Eng. & M. of W. Association for inspection of bridges will give satisfactory results.

F. B. Scheetz, Missouri Pacific Ry.:

I am sending you herewith a copy of our general instructions No. 4 covering the inspection of bridges. There are a few changes in this copy from the original, and this form is my idea of bridge inspection.

We have no standard form covering the inspection of buildings, but the supervisor makes an inspection of all buildings once a year, about September, when preparing his program for the ensuing year. About the first of July he makes a special trip to secure information for the necessary stove repairs.

The only standard form we have for making reports on bridges is M. W. 74, as shown on blue print attached.



Size of Sheet 8" x 10½"

REPORT NO.

C. R. R. OF N. J. DIVISION

CURRENT BRIDGE INSPECTION REPORT.

HAVE TO-DAY INSPECTED BRIDGE NO.

AT

AND FIND ITS CONDITIONS AS FOLLOWS:

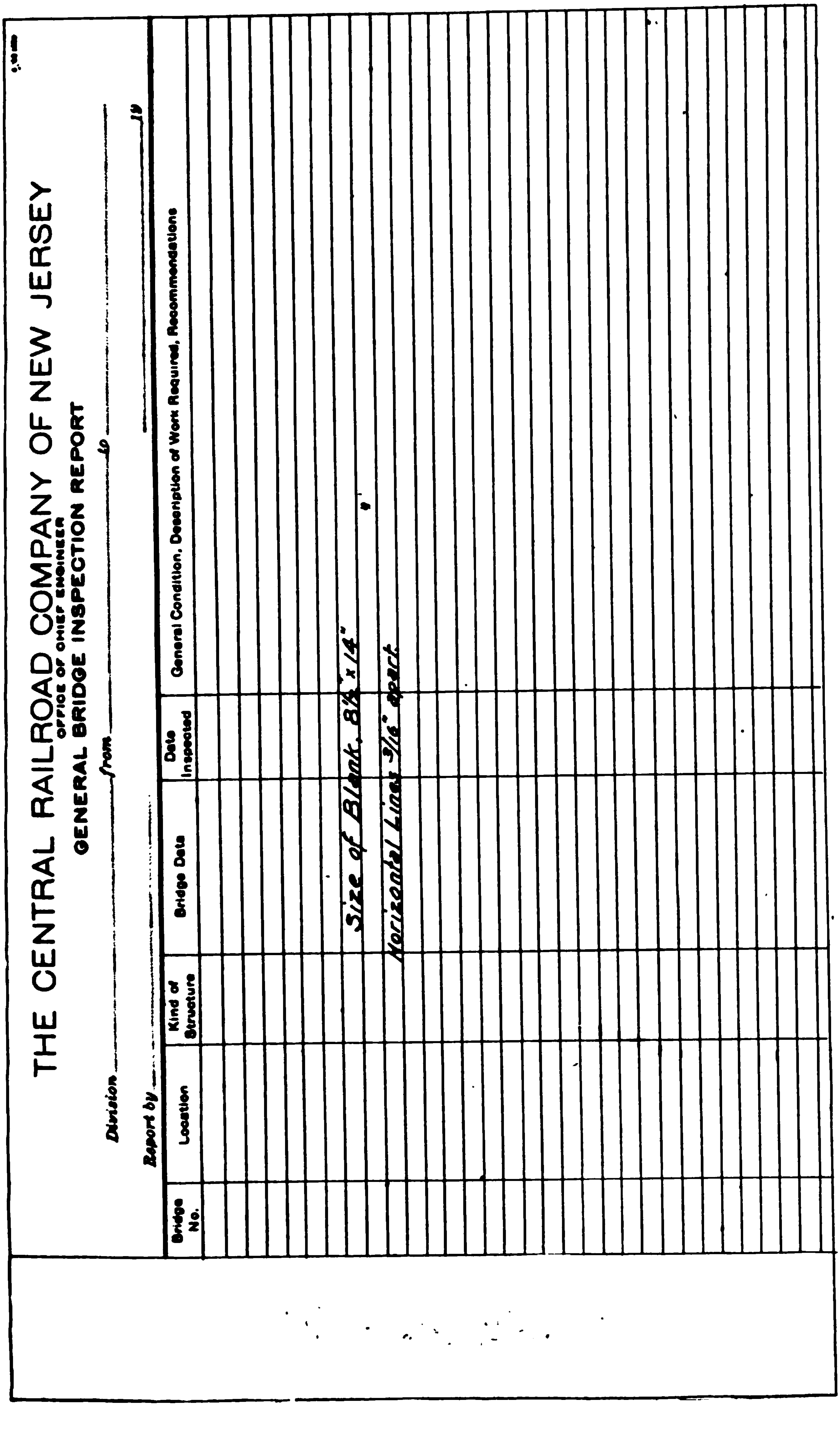
THE FOLLOWING WORK IS REQUIRED TO MAINTAIN THE STRUCTURE IN GOOD CONDITION:

THE FOLLOWING WORK MUST BE DONE TO KEEP THE STRUCTURE SAFE:

DATE ________190 ________ INSPECTOR.

NOTE:- MAKE SEPARATE REPORT FOR EACH STRUCTURE. SEND REPORT TO THE ________ IN CASE OF DEFECTS REQUIRING IMMEDIATE ATTENTION. SECTION MEN AND OTHERS CONCERNED MUST BE NOTIFIED AT ONCE AND TEMPORARY REPAIRS MADE.

Central R. R. of New Jersey, Current Bridge Inspection Report.



THE CENTRAL RAILROAD COMPANY OF NEW JERSEY
OFFICE OF CHIEF ENGINEER
GENERAL BRIDGE INSPECTION REPORT

Division ______ from ______ to ______ 19__

Report by ______

Bridge No.	Location	Kind of Structure	Bridge Data	Date Inspected	General Condition, Description of Work Required, Recommendations

Size of Blank 8½" x 14"
Horizontal Lines 3/16" apart

Bridge Inspection Report Blank, C. R. R. of N. J.

In order to get authority for replacing a pile trestle with steel structure it is necessary to have a survey made, getting all the necessary information as to drainage area, the size of opening required and depth and kind of footing for new masonry; then an estimate is prepared showing the comparative cost of existing structure with proposed permanent structure.

This gives the chief engineer the information necessary to decide what action should be taken, and if he decides upon putting in the permanent structure the matter is taken up with the general manager asking for authority, and if authorized authority for expenditure is prepared, covering the cost of all work pertaining thereto.

When replacing light iron spans with heavier structures the same routine is carried out, except as a general rule the vice president or general manager asks to have a certain line increased to carry heavier power and a blanket authority for expenditure is prepared, to cover all structures on that particular line.

General instructions for inspection of bridges are as follows:

1. The division engineer shall keep a record of all bridges on his territory, embodying the following information:

Character of structure.
Length of spans.
Number and length of panels.
Depth from base of rail to ground line at each panel point.
Character of the ground.
Extreme high and low water line.

In addition to the above, in case of frame or pile trestles the following information shall be given:

Number of and sizes of stringers.
Penetration of piles.
Number of piles in each bent.

2. The supervisor shall keep all structures safe at all times. He shall carefully investigate the reports of all inspections and shall take the necessary steps for the correction of the defects, and in cases of emergency he shall take such temporary action as is necessary for safety without waiting for orders, advising the division engineer immediately whatever action is taken. Permanent repairs, or improvements, must be covered by special authority.

4. All masonry as well as the superstructure must be kept clean and free from rubbish, drift removed from the channel, and grass, weeds or refuse removed from within at least ten feet of every wooden structure.

5. Track foremen shall report to the supervisor and roadmaster new defects in bridges discovered by them while passing over their sections or reported to them by others.

6. At least every four months the supervisor will personally examine each structure on his division and he will see that a competent bridge man shall inspect every bridge at least once in two months, and the supervisor will make detailed reports of all defects to the division engineer.

7. Every six months the division engineer will personally examine each structure on his division. He will also at other times personally examine any defect affecting the safety of the bridges reported by the supervisor and will send to the engineer maintenance

of way a detailed report of every such defect in any structure as soon as discovered.

8. In the fall of each year the division engineer in company with the supervisor shall make a joint inspection of all structures for the purpose of preparing a preliminary program of work necessary to be done for the ensuing year. This program complete with estimate shall be in the office of the chief engineer maintenance of way not later than November 1.

2. Once a year inspectors designated by the chief engineer maintenance of way will make a joint inspection in company with the division engineer and supervisor for the purpose of preparing an authorized program of all work that will be required during the coming year.

E. E. Wilson, New York Central & Hudson River R. R.:

We make a complete inspection of all bridges and culverts every three months, made up on a printed form for that purpose (our number M. W. 48). This is made in duplicate and the original is forwarded to the division engineer, on the first of April, July, October and January. Items on this report are indicated by letters, a, b, c, and a dash. All items needing immediate attention are marked "a." Those that can wait until the next inspection are marked "b" and those that can safely wait for one year or more are marked "c." All items not needing attention are marked with a dash.

The first three inspections are made by the division inspector and the last one, which is submitted on the first of January, is made by the supervisor, in company with the inspector. These constitute the regular inspections. In addition to these, we make special inspections, and reports by letter or wire, of all bridges that need it.

During the last quarterly inspection we make up a list, or budget, of all the work we think should be done during the following year, giving, at the same time, the estimated approximate cost of each job.

In the matter of getting an authority for rebuilding a bridge: First it must appear on the budget for that year; then we make up a detailed statement of the estimated cost of rebuilding on a printed form, which must be approved by the engineer maintenance of way, and the chief engineer, before the work can be started.

The division inspector is out on the road practically all of the time; starting from one end of a division or branch, and stopping at each bridge or culvert, and making notes of the conditions, as he finds them. He travels on a motor car, or hand velocipede car, as the conditions of the traffic warrant, and reports to the supervisor's office each morning about what territory he will cover that day.

R. H. Reid, Lake Shore & Michigan Southern Ry.:

We have a monthly inspection of all bridges and culverts made by the roadmasters over their respective divisions and reporting to the assistant chief engineer. This report is forwarded to the supervisor of bridges for his examination, and such attention as may be needed. Also a semi-annual detailed inspection is made each spring and fall by the bridge inspectors. We have two bridge inspectors, one east, and one west of Toledo. These men go over

Size, 9" Vert. × 11½" Hor.

M. W. 45. 6M.S. 7-8-08-2M
9⅜ × 11⅞

New York Central & Hudson River Railroad Co.

No. ....

LEASED AND OPERATED LINES.

MAINTENANCE OF WAY DEPARTMENT.

Report of the Supervisor of Bridges on the .... Div. for .... Quarter, 190.....

.... Main Line .... Branch.

Bridge No	Type of Structure	Date Inspected	Condition	Foundations	Masonry			Timber							Superstructure																			Action Under Train	Special		Remarks and Recommendations	This Col will be filled in by Chief Eng'r
					Point	Repair	Renew	Ties	Guard Rail	Blocking	Stringers	Piles	Posts, Caps, Sills	Bracing	Bed Plates	Rollers	Pedestals	Posts	Main Trusses	Girders	Laterals	Floor Syst.	Ties	Hangers	Castings	Drain Holes	Paint	Loose Rivets: Trusses	Girders	Laterals	Sways	F. B. Con.	Str. Con.		Date Rep't'd	Date Req'd		
																																					Hor. lines Spaced 1/6 in.	

Dated 190

.... Supervisor of Bridges.

Bridge Inspection Report Blank, N. Y. C. & H. R. R. R.

their divisions on gasoline motor cars, examining every bridge, culvert, turntable, overhead structure, coal chute, and similar structures which come under the jurisdiction of the bridge department. The spring inspection is made as soon as practicable after the snow and frost are out of the way, and when the water is not so high as to make it impossible to see the foundations, and the parts of piles and timber at the ground line. The fall inspection is made in the latter part of September and October, when many streams are very low or dry, and there is the best opportunity to get at foundations and ground work. The bridge inspectors make a written report of their inspection on each division, sending it to the supervisor of bridges, for use and reference in his inspection.

The supervisor of bridges and engineer of bridges, accompanied by the bridge inspectors and the roadmasters of the various divisions, make a semi-annual general inspection of structures, using an engine and coach for these trips. The general inspection is usually commenced early in May, after the bridge inspectors have been over their divisions and made the detail inspection and sent in their reports. On the general inspection, we check up reports of the bridge inspectors, examine all structures which may be in need of attention or repairs, passing over iron pipe and concrete and stone box culverts and other similar structures which have been examined by the inspectors and are known to be in good condition.

The fall general inspection is made in October and November and followed up as rapidly as possible, in order to complete it before bad weather sets in. We examine all iron structures for rust and smoke corrosion, loose rivets, adjustment and bearings, and in fact everything about the metal structure; also examine for settlement, or moving out of position, due to insufficient foundation, cracking, and general conditions.

Wooden structures, such as pile bridges, and trestles, are examined for condition of timber and piles, loose bolts, line, surface and other conditions, the same as iron structures, and full notes of the conditions of such structures are made on the ground while making the inspection. These notes are made on plain ruled leaves in a loose leaf cover, the same size as the leaves used for the bridge record in the inspection book.

The renewal lists are made up from the notes of our fall inspection, at which we determine which structures shall be renewed the following year, and after the assistant chief engineer has approved them, one copy of each sheet approved is returned to the engineer of bridges with the approval of the assistant chief engineer, and a numbered advice issued, showing to what account to charge the cost of the work, when the structure is renewed.

A. H. King, Oregon Short Line R. R.:

We make a general inspection of bridges and buildings in our jurisdiction, commencing usually about the first of September. This inspection is made by the division engineer, general foreman of bridges and buildings, and superintendent of the division.

Our practice is to make use of the superintendent's private car, and run a special, in looking over bridges, buildings, etc., on the division. At that time, the notes are taken in a book, blanks of which I enclose you, and report is later written up by the division engineer and submitted to the superintendent of the division, who

Copy Ink. FORM 2712. S. 2738. 1000. 4-06. (GES 75246)

The Lake Shore & Michigan Southern Railway Co.

ENGINEER DEPARTMENT.

Road-Master's Bridge and Culvert Inspection on............................ {Branch or Division.} during............................190....

Having made a careful personal inspection of Bridges and Culverts on this line within........days of date, I find all to be in good condition, except those enumerated below.

Class and Number.	Kind of Structure.	Date of Inspection.	Condition.	REMARKS.

Size, Hor. 8½" x Vert. 14" Lines Spaced 5/16"

Bridge Inspection Report Blank, L. S. & M. S. Ry.

in turn makes his recommendations and submits the letter to the general superintendent and chief engineer.

Usually the chief engineer makes a trip over the division about the last of the year, if he thinks necessary, and makes any suggestions or changes which may seem proper to him, supplementary to the other report, which is then sent to the general manager, and general manager's orders (called G. M. O.'s) are issued authorizing the work for the ensuing year.

This refers to our general repair work; should we see fit to recommend new structures in place of existing old ones, it is written up on the same schedule.

In reply to your question, asking what steps are necessary to get authority for rebuilding a bridge: I am in the habit of writing a letter, explaining conditions of the structure, and making recommendations requesting authority for the changes which I propose. This letter is made to the division engineer, who passes it along to the division superintendent, general superintendent, chief engineer, and general manager, and an order on the regular standard form called G. M. O. is issued when the work is authorized.

I consider the foregoing plan an ideal system for bridge and building inspection. It is the one which has been in practice on the Harriman lines for the past ten years.

M. F. Cahill, Seaboard Air Line Ry.:

Once a year the general bridge inspector and the master carpenter of each division make an inspection together and ascertain just what is needed for each bridge and building. The estimates are made up by the master carpenter with requisitions for material, and forwarded to general headquarters for approval.

In the case of renewal of a bridge, the foregoing is all the authority necessary, except in the case of a metal structure, which is handled by the bridge engineer.

General instructions for bridges are as follows:

1. Master carpenters shall make a special and thorough inspection of every bridge and open culvert on their division at least twice each year, once in the spring and once in the fall, in addition to the monthly examinations. During the fall inspection special attention must be paid to obtaining data for estimating the cost of renewals and repairs and for ordering material required for the coming year.

2. The bridge inspector will be detailed by the chief engineer to go with the master carpenter during the fall inspection, and they shall both inspect every bridge and open culvert and shall enter in these bridge inspection books full notes of such inspection, each one keeping a separate book.

3. These notes of inspection must show the condition of every bridge (including overhead wagon bridges) and open culverts in both main and side tracks; enter the length and height (ground surface to base of rail at highest point) of all bridges; enter overhead bridges and culverts between the proper bridge numbers, showing the length, width and clear height above rail of overhead bridges and the length, width and height of all open culverts; also state the kind of open culvert.

4. Where the structure is in good condition, requiring no repairs for one year, it will be sufficient to make it O. K. in column of

SEABOARD
AIR LINE RAILWAY

Condition of Bridge and Description of Work to be Done	MATERIAL REQUIRED

Left Hand Page of Bridge Inspection Book. Seaboard Air Line Ry.

Size of Page 5¼" x 8½"

....Division.

Bridge No.	KIND (Pile, Trestle or Truss)	LENGTH	HEIGHT	Date Inspected

Horizontal Lines. 1/4" apart

Right Hand Page of Bridge Inspection Book. Seaboard Air Line Ry.

"Condition of Bridges." Where the structure requires repairs or renewals within one year, enter in the notes a concise statement of condition of the various parts of the structure, the piles, trestle bents, caps, stringers, ties, etc. At truss bridges note the condition of the various members, the camber, alinement, etc. Note whether waterways need cleaning out or straightening or whether any riprapping is required.

5. The notes of the fall inspection must show what materials are required for repairs or renewals for the coming year, measurements being made for length of timber or piles required, and where the ground is soft, soundings are to be taken and notes recorded.

Where the structure requires renewing or extensive repairs, the notes must show whether any filling in can be done, stating what kind and size of opening is required to carry the water. In this connection, note whether the structure is used as a cattle pass or under-crossing for teams. In the case of wooden culverts requiring renewing, show what size and length of iron pipe or other permanent structure will be required to carry the water.

6. The master carpenters are responsible for the safe condition of all bridges and open culverts on their divisions. Should any bridges or open culverts be found that require immediate repairs, the master carpenter must have the necessary repairs made at once, reporting the facts to the division superintendent.

7. A copy of the notes of fall inspection as made by the master carpenter must be made and forwarded to the chief engineer as soon as possible after the inspection is completed.

N. F. Helmers, Northern Pacific Ry.:

At the present time most of the inspection is made personally by the supervisor, although a carpenter is sent over the district about once a month to inspect and adjust mail cranes and do other minor repairs.

In September of each year an inspection of all bridges is made by the division engineer and supervisor of bridges and buildings, accompanied by the division superintendent, and on the basis of this inspection a report is prepared by the division engineer, together with estimates for the various items. This report or form then passes to the chief engineer, general manager and third vice president, and approval of it usually reaches the division officers during the winter so that requisition for material can be made at that time. This form covers all bridge and culvert work which is to be done during the season and all large items of permanent bridge work are stricken from it and authority granted under special improvement numbers. The form covers rebuilding of all timber structures.

We do not use any special form for making these reports. Nearly all of our supervisors are provided with gasoline motor cars and have little trouble in making a personal inspection of bridges every five or six weeks.

As to what would constitute an ideal system of bridge and building inspection: There is only one criticism I have to offer to our present system; that is the fact that it would be more economical to have a bridge inspector receiving a salary of $95 or $100 per month, whose duties it would be to make inspection of all bridges and buildings, and also handle all minor building repairs. By

giving this work to one man, it would be handled more promptly and with less loss of time than under the present system.

I am a firm believer that as much inspection as possible should be made by the supervisor personally.

P. Swenson, Minneapolis, St. Paul & Sault Sainte Marie Ry.:

I have regular bridge crews of six and seven men that take care of 250 to 300 miles of road. These crews make repairs to bridges, culverts, water stations and buildings of all kinds. I make two inspections each year, going over the road on a gasoline motor car; one in the spring and one in the fall. The fall inspection I make very thorough, taking in everything in regard to bridges, buildings and water stations. If any recommendations are made for new work I prepare an estimate and blue print, and take the matter up with the president, general superintendent and chief engineer, to whom I report. If they approve of my recommendations I order the material and do the work.

M. Bishop, Chicago, Rock Island & Pacific Ry.:

I am enclosing herewith such forms as we use. Book form MW 87 is used for bridge inspection, which is self explanatory. The building inspection is made at the same time on an ordinary memorandum book—no special form. The estimate of cost is made up on Form MW 54 (amounts given to the nearest $5), and the revisions are made in the chief engineer's office, then passed to the president for approval. This constitutes the maintenance work sheets for the year for the bridge and building and water service department. These MW 54's are made up according to the several accounting numbers, which are used to comply with the interstate commerce commission laws. This covers the maintenance feature proper.

When there is a question regarding the safety of iron, steel or wood truss spans, the inspection is made by a competent man from the bridge engineer's office. There is an inspection made by the foreman about every two or three months, so as to keep in touch with conditions as to safety.

The general instructions for inspection of bridges are as follows:

There shall be one regular inspection each year, beginning the first of September, by the master carpenter and some competent man from the engineering department, of all bridges, culverts, waterways, etc. This inspection shall be made with special reference to obtaining data for estimating the cost of renewals and repairs for the ensuing year and probable renewals for the second following year.

Inspection notes must be kept by both the engineer and master carpenter in separate books of this kind and must agree, and must show that each bridge or culvert has been inspected, whether requiring repairs or not, and in the case of renewals, give recommendations.

The district engineer will report the result of these inspections to the general superintendent and the engineer maintenance of way.

Division superintendents are responsible for the safe condition of all bridges and culverts on their divisions.

The master carpenter will make, or have made, such additional inspections as are necessary.

Size of Page, 4¼" x 9½"

_______________ DIVISION.

GENERAL BRIDGE INSPECTION REPORT

STRUCTURE NUMBER _______ KIND OF STRUCTURE _______ LOCATION MILE _______ BY _______ 190__

No. of Bent	Number of Pile or Post						Cap	Sill	Height Base of Rail to Ground at By	No. of Span	R. or L. Truss	No. of Panel	Number of Stringer or Piece								Length of [illegible]
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6							No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	

Horizontal Lines 1/3" apart

C. R. I. & P. Ry. Bridge Inspection Book. (Bound at middle of sheet.)

D. W. Lum, Southern Ry.:

The bridges are personally inspected by bridge supervisors and roadmasters every three months, and a report is made on a regular printed form.

The bridge supervisor makes inspection of the trestles every two months, and records his observation in ordinary blank books, which are sent to the engineer maintenance of way of his district.

The ordinary trestles are rebuilt from time to time with the organized forces without special authority, as this work is considered in the line of maintenance. Where new bridges are required, an estimate of the cost is made and forwarded to the vice president and general manager, with a description of the conditions and the need for the expense; and when such expense is approved, the plans for the structure are made, contract awarded to the bridge company, and the work supervised by representatives of this office.

J. E. Cole, Central Vermont Ry.:

We make our inspection in April, accompanied by a stenographer, and a bill of material is made on the ground. In regard to authority for doing bridge work: Our company does not consider it necessary to give authority for minor repairs; however, I send the chief engineer a copy of the work sheet; also send each division foreman a copy covering his division. By this report I can estimate what it will cost to maintain the bridges for the coming year. I then make another inspection in October, but do not make a work sheet, as this inspection is for the purpose of keeping in touch with the general condition of the bridges. The buildings I do not take up in this manner. I make recommendations of repair work to buildings direct to the chief engineer. Construction of new stations originates in the office of the general manager and comes down through the chief engineer's office to me for construction.

G. Larson, Chicago, St. Paul, Minneapolis & Omaha Ry.:

The rules of this company provide that the supervisor of bridges and buildings should personallv inspect all important wooden trestles and iron bridges in the month of January, first inspection. The second inspection is made jointly with the bridge inspector and supervisor of bridges and buildings in Aoril, of all culverts and bridges and are then closely examined and if it is found that anything is necessary to be done special form must be sent in for authority. The third inspection is made in the month of September. This is made jointly by the bridge inspector and supervisor of bridges and buildings. On this inspection we provide for our next year's work. Recommendations are made to the management as to what structures should be rebuilt or repaired and a list is made and forwarded to the division superintendent; he sends it to the general superintendent, who in turn sends it to the general manager and chief engineer. After the management has decided how many of the bridges will be rebuilt as permanent work, we receive what is called an "approval list" and are authorized to make form 1720 for approval and order material to comply with revised list.

The inspections above mentioned are all right. The January trip is not intended to cover small structures, but it gives the inspector an opportunity to get under structures on the ice, which is generally on the rivers in our territory during that month.

We inspect buildings in the spring and fall. Those structures which need repairs or renewals are reported on form 1720 for the buildings the same as for bridges.

G. E. Hanks, Pere Marquette R. R.:

An inspection is made annually of all bridges by the engineer of bridges and buildings, accompanied by the division engineer and master carpenters, using a motor car for conveyance. This inspection is supplemented by one made quarterly by the division engineer, his assistant, or the master carpenters, one of them endeavoring to visit each bridge during each quarter by the use of a motor car. A program is prepared from notes gathered on the annual inspection, covering all work in the nature of painting, renewing ties, piles, bank walls, etc., which is to be handled in the regular order of our season's operations, and also covering all renewals of old structures. This is supplemented by notes gathered on the quarterly inspection.

All plans for the construction of bridges are prepared by the engineer of bridges and buildings. Estimate of the cost of constructing the bridge is made by the division engineer. This is then forwarded to the general manager as a recommendation, but upon being approved by him becomes our authority for doing the work.

R. J. Arey, Santa Fe, Coast Lines:

My idea as to what would constitute an ideal bridge and building inspection is this: That a force consisting of division engineer, or a representative of the engineering department, division superintendent, and general foreman of bridges and buildings be detailed for the inspection. They should go over the division at least once a year and inspect all bridges, and each and every building should be inspected and that a book be used to record the inspections made and date thereof. One page should show location and kind of buildings, giving the dimensions; then, in a separate column, show notes of a thorough inspection of substructure and superstructure as per their several parts, and on the right hand page the general condition of the buildings should be noted, and if repairs are to be made a column should be headed "Material required," and number of pieces and quantity in kind should be noted therein. In this way we would have a complete record of each building, the condition of same, date and amount of repairs required in all of its parts. This would make it an easy matter for the general foreman to get up his list of budget items for repairs and renewals of buildings, and would also be of great assistance to officials of the operating department to know just what condition the structures are in, and would be of value to the engineering department in making up insurance schedules and such similar data as they are called upon from time to time to compile.

E. K. Barrett, Florida East Coast Ry.:

As soon as possible after the first of January I take the foreman on each division and inspect every structure, both bridges and buildings, thoroughly, and on the ground I enter in my note book just what material is neccessary to make the structure safe for the coming year.

Answering your question as to the steps for rebuilding a bridge:

If it is simply a case of replacing a wooden structure no authority is neccessary on this road; it is simply up to me to go ahead and do the work. If, however, it is desired to rebuild or replace a wooden structure with steel, I would get my authority from the superintendent of maintenance of way, and he in turn would get his from the vice president.

In regard to forms or blanks used in making inspections, we have none. Our records are all kept in book form and can be referred to at a moment's notice should a report of the inspection be desired.

Answering your question in regard to my ideas as to what constitutes an ideal system of bridge and building inspection: Of course, we all think our own pretty good, and, as the system I am now using has thus far proved entirely satisfactory I, of course, think it a very good one. This method was employed by Mr. Carter before I came here 8 years ago, and in all the years that we have operated there never has been a wheel on the ground which could in any way be laid at the door of the bridge and building department.

In addition to the inspections above mentioned, I make three others each year, looking over the structures to see that the work has been done as instructed; also to see if anything has developed since the last one to need immediate attention.

J. S. Berry, St. Louis Southwestern Ry.:

I make a general inspection of all structures on the system in charge of the B. & B. department on a motor car once a year, taking the master carpenters, bridge inspectors and foremen on their respective divisions, along with me over the system, and inspect all bridges and buildings and all work that comes under the B. & B. department, including water service.

Notes are made on our trestle and buildings records of the condition of all structures on the ground at the site of the structures, whether renewals or repairs are required. After returning to the office I make up what we call a work sheet, giving the number and kind of structures and character of repairs required, together with lists of materials necessary and itemized statement of cost. This we submit to the general manager for his approval.

H. M. Jack, International & Great Northern R. R.:

I make a personal inspection of each trestle, bridge and culvert once a year, making a bill of material at each place and designate the time work is to be done. Other inspections are made by myself. and by gang foremen on short stretches of road, when convenient, and when working in each district, after making annual inspection, I make requisition for material needed for the year. When the requisition is authorized it is authority to do the work as fast as material is received. I have no form to write inspections on.

The only improvement I would care to see made on the above would be, to have an inspector to work periodically during the year.

H. D. Holdridge, Yazoo & Mississippi Valley R. R.:

BRIDGE INSPECTION.

Each bridge foreman is assigned to a certain district; he makes a careful examination of all bridges and culverts on his district once

Size, 8½" Hor. - 14" Vert.

Form 1184.
Revised 5-05.

Illinois Central Railroad Company.

....*Division.*

Inspection Report of Bridges and Culverts {*Month* / *Quarter*} *ending*.................................*190*___

Send Copy at end of each quarter to Road Master.

Date of Inspection	Bridge No.	Length	Kind of Structure	No. of Bents	No. of Piles	When Built		Condition	Work Needed in Next 3 Months
						Year	Month		
									Hor. lines spaced 7/32"
									Supervisor Bridges and Buildings.

Bridge Inspection Report Blank, Illinois Central R. R.

every thirty days, reporting to my office only those structures which should receive attention within the next 30 days.

I make a quarterly inspection of the entire division, accompanied by each foreman over his respective district, a copy of the report being sent to the road master.

In addition to the above, I make a thorough inspection during the month of November to ascertain the amount of work needed during the ensuing year. In this report I give complete description of the work to be done, together with the cost. This is approved by the road master and superintendent and forwarded to the engineer of bridges.

BUILDING INSPECTION.

I make an inspection of buildings in connection with the quarterly bridge inspection, but no regular forms are used for this. In making the annual bridge inspection the same attention is given to the buildings, and similar report is made covering the work needed for the coming year.

AUTHORITY FOR RENEWING BRIDGES OR BUILDINGS.

In making the annual recommendations for the coming year, if we have a structure, either bridge or building, that requires an expenditure of several thousand dollars, we do not include it in this report, but, instead, it is put under the heading of "special work" and attached to the other report, each item of this special work is then followed with a work order application. If this work is approved a number is given to it, and the necessary appropriation made. My office is notified to this effect and is given the number which covers the appropriation. This number is used in referring to the work until it is completed.

For ordinary repairs and renewals, our recommendations are gone over by the engineer of bridges and buildings, and after being revised or approved are returned and then a monthly allowance made on the first of each month on bridges and culverts, miscellaneous buildings, shops, engine houses and turntables, fuel stations and water stations. This money can be applied to any work as outlined in our recommendations.

Very often we find it necessary to do work that was not included in our yearly recommendations. If this is of any magnitude it is taken up special by letter and a work order application sent in. In this way authority is obtained. If the work should be of such a nature that we could not wait for this authority we proceed with the work, marking on our requisitions for material, also on payrolls, "authority to follow." These amounts are then held in suspense in superintendent's office until formal authority is received.

Chicago and North Western Ry.:

GENERAL INSTRUCTIONS FOR THE INSPECTION OF BRIDGES.

There shall be one or more general inspectors for the entire road, who will report to and receive instructions from the chief engineer, and whose duty it shall be to make examinations and report thereon, of the condition of all important bridges and culverts, several times each year. In an emergency the general inspector may, on his own authority, order such repairs made as he may deem necessary for safety, at once advising the division superintendent

and chief engineer of his action, using the telegraph only in extreme emergency, but otherwise his recommendations will be carried out through the chief engineer.

There shall be 2 regular inspections each year, as follows:

1. In the month of April by the foreman of bridges and buildings. Brief report of this inspection will be made to engineer of maintenance by division engineer.

2. In the months of July, August and September by the division engineers, and foremen of bridges and buildings of divisions, of all bridges, culverts, waterways, coaling trestles, turntables, etc. This inspection shall be made with special reference to obtaining data for estimating the cost of renewal and repairs for the ensuing year.

The purpose of the spring inspection made by the foreman of bridges and buildings is to see if any of the structures are in need of immediate repairs. This will give him a general idea of the condition of the bridges and he can arrange his season's work accordingly.

The purpose of the fall inspection, made by the division engineer and the foreman of bridges and buildings, is to note what work will be necessary for the maintenance of the bridges during the ensuing year.

The inspection made by the general bridge inspector is independent of that made by the division officials and acts as a check on them. Inspection recommendations for the rebuilding of pile bridges and other temporary structures as permanent structures are made by the general bridge inspector. There is one general bridge inspector and 2 assistants. These men inspect all culverts and bridges on the entire road during the time from April 1 to October 31. At other times they make special inspections of the more important bridges, paying special attention to those which are old and somewhat light for the traffic they carry.

DISCUSSION.

Mr. A. S. Markley.—On the blanks shown in the first part of this report as being used by the Oregon Short Line, Chicago & Northwestern and Atchison, Topeka & Santa Fe roads there is no space provision made, as far as I can see, on which the inspector can make his notes as to the defects in the bridge and what repairs and materials will be required. The left-hand page of the O. S. L. blanks gives spaces for number of bent, numbers of piles and for caps, spans and height, and on the right-hand page of their blank is given practically the same thing.

Mr. Jutton.—I think that this blank is criticised for just that reason; that it is divided up too much and does not give an inspector enough space on which to report what he finds. If you will note the blank shown on the next page, used by the C. & N. W. Ry., the left-hand page is left entirely blank,

which gives the inspector a chance to state what the defects are as well as the bill of material necessary. There are, of course, any number of different kinds of blanks used for making inspections.

Mr. A. S. Markley.—If an inspector had to report repairs necessary on many of the items shown on the C. & N. W. blank he would certainly run out of space. The lines are too close together.

Mr. Jutton.—The idea there is that the description of the structure is to be written up on the right-hand page before the inspector starts out. I think, however, that the best way of writing up these daily inspection reports is to state what you find, and not to have any definite form to follow, as you cannot always assume what is going to be the matter or how much space you are going to need.

Mr. A. S. Markley.—That is very true, and just the point I wish to make. There is no ruled-up inspection book that is worth the paper it is made of. I have fully explained in this report our method of inspection. All our bridge books are written up beforehand, in their rotation, and where there is a large bridge we leave a space of three or four pages. That has been our method for twenty-five years, and I can go into our office and check back every structure that has been repaired in the last twenty years and put my hand on the foreman who did it. All our bridge records are written up from these note books.

Mr. Clark.—The simpler one can get a book for bridge inspection the better the inspection will be. What is the sense of an inspector who goes over the line once a month putting down the length or height of a bridge? All an inspector is employed for is to find the defects. The master carpenter has his bridge records, and if the inspector tells him there is a defect in the fourth, fifth or sixth pile his records will show him where that is. The simpler we can have our inspectors' reports made to us the better it will be for us, and that will be the cheapest for the company. It is all wrong to load down our inspectors with a lot of writing

when they are on inspection work. All that should be necessary for them to do is to state the number of the bridge, what the defects are and give the approximate time in their opinion when those defects should be remedied.

Mr. Andrews.—On our road each division has one or more local inspectors, the number depending on the mileage and the number of bridges. These inspectors are supposed to examine the substructure and superstructure of each bridge, and make a report to the master carpenter showing the defects found. The blanks are in very simple form, showing only the date inspected, bridge number and space for remarks. They are printed in book form, with perforated leaves, and the inspector writes them out in triplicate, keeping one copy, so that if anything serious happens to a bridge he will be in position to show that he has made an inspection and reported defects on a certain date. On receipt of these reports the master carpenter notes them, and if anything serious is the matter he is supposed to take immediate steps to remedy the trouble, at the same time forwarding one copy of the report to the chief engineer. If the master carpenter is not in position to take immediate steps he asks for assistance or special instructions.

Semi-annually the division engineer makes a report in triplicate to the engineer of maintenance of way, who forwards two copies to the office of the chief engineer. Our form is very much like that submitted in this report as being used by the Central R. R. of New Jersey, and gives the number of the bridge, date inspected and space for reporting defects found and action taken. By our method all departments are kept in close touch with the condition of the bridges. We also have, of course, a book record of every bridge, with a description and sketch of each bridge on the system, and when there is a report of a defect, the size, design, etc., can be found in the book record.

Mr. Jutton.—Mr. Clark has stated that inspectors should not be required to put down on their inspection reports the length, class and such items regarding the bridges he in-

spects. Now it was not intended in this report, anywhere, nor do I think it was intended by any of the roads from which I secured information, that the inspectors should do this. The idea is that when the annual inspection is to be made the inspector should be supplied with a book of blanks, one side of which should give all items descriptive of every bridge. Then if he finds that changes have been made which have not been recorded the correction should be entered in his book, and our records in that way are kept up to date. Many times, for one reason or another, there will not be a number on a bridge, and his record will help an inspector who is not familiar with his territory in making up his report; and in case he has passed over some culvert hidden from view he will find it out at the next bridge and go back and get it. It is not supposed that these blanks are to be filled out with descriptive matter while they are on their inspection trips.

Mr. Andrews.—Our sketches are kept up to date in this way: Any changes or additions to bridges must be reported by the master carpenter, at once, to the engineer of bridges, who, in turn, forwards corrected blue prints through the regular channels to the various officers for insertion in their bridge books. In that way we keep them up to date all the time.

Mr. Reid.—On the Lake Shore & Michigan Southern Ry. we keep a small pocket-book giving a complete record of all culverts and bridges on the system. On wooden bridges we show the number and size of stringers, the size and length of caps and any other information in which the bridge varies from the standard. On girder bridges we give only enough information to definitely fix the bridge. In the case of the iron truss bridges we do not go into all of this information. We show whether it carries one, two, three or four tracks, and the spacing of the stringers, but nothing further, as we have in the office complete detail plans of all the iron bridges on the road and also of any special wooden bridges. On the inspection trips these pocket-books are

taken along, and if any changes have been made they can be picked up by the inspector.

Our books are small loose-leaf affairs, and enough blank pages are put in at the end of each division on which to make the inspection reports, new leaves being put in as may be necessary to take care of current reports. The records are also kept checked up on the weekly reports of the foreman. If work is done which has not been ordered and for which there is apparently no reason, the foreman is asked to explain. If work is not done which should be done and they fail to report, they are also asked to explain, and in this way we keep check of all work to be done. I keep carbon copies of all uncompleted bridge work orders in my desk until the work is completed, so that our bridge records are complete up to the week, all the time.

Mr. Sheldon.—It would seem to me that the report blank shown as used by the Lehigh Valley R. R. is one elastic enough to cover the inspection of all classes of bridges, and with spacing enough for the notation of whatever might be needed to cover the general condition of all classes of bridges. One thing about it I like is that there are but three lines to the inch. It seems to me that by using a carbon with this blank, so that the inspector can retain one copy, sending the original to the proper official, this blank should answer all practical purposes.

Mr. Jutton.—The inspection blank shown in this report as used by the Central R. R. of New Jersey answers the same purpose, and you will note that it has no horizontal ruling at all, which gives the inspector a chance to report what he has to say. These blanks, I think, are very essential, and as I understand it are sent in monthly, or once in two months. Every bridge should be inspected or looked at by a competent bridge man at least once in two months, and perhaps oftener, making a report on such a blank as this and indicating thereon either that the bridge is safe or else that it needs certain repairs. This blank I think answers all purposes very well.

Mr. Hofecker.—The blank shown in the report as being used by the Lehigh Valley R. R. is, of course, very familiar to me, as our road has adopted it and used it for some time. The bridge inspector makes this form out in duplicate, one for every bridge, and submits his reports daily, one going to the division engineer and the other to the supervisor of bridges and buildings. This keeps both of them in touch with the condition in which the inspector finds the bridges. If immediate attention is needed we have the carpenter look after it at once. The inspector visits each bridge about once in two months. It may be a little longer, but that is about the time it takes him to cover the division. On the next page is shown the form of report which is used for summarizing the reports made daily during the month, one copy being sent the bridge engineer for his information. The bridge records are kept corrected from reports made by each foreman of all the work he has done during the month, which are sent to the engineer's office, and from which he corrects what we call our report of the " physical characteristics " of our bridges. The bridge inspectors' reports are filed in such a manner that they can very readily be looked up.

Mr. A. S. Markley.—There is nothing provided here for culverts or structures of that kind. I presume this blank could be used for that purpose.

Mr. Hofecker.—Our system of numbering bridges is such that by its number we can tell whether it is a pipe or a small bridges under five feet, there being a letter before the number on such structures.

Mr. Killam.—Bridge inspection is something in which I have taken a great deal of interest. When I came to the Intercolonial Ry. I went over the system from end to end and examined the reports made on our bridges and culverts, and found them very defective, so that I inaugurated a system which took me two years to accomplish by starting in at one end of the line and going to the other. I measured and made records of and numbered every bridge structure and station building on the fifteen divisions, there being some-

thing like 5,000 bridges and culverts, and from this information I prepared a record book 24 inches wide, with columns down the side describing each structure in detail, so that now when a report comes in or is telegraphed regarding the condition of any structure this book can be referred to and all details obtained. From this book I made up fifteen division books which I take with me on my yearly inspection trip. I revise this record book about every six years.

Mr. Hofecker.—I note that there is nothing shown on the blank which we use on the Lehigh Valley R. R. to indicate whether it is to be used for an arch, pipe or culvert. As you will see, however, there is a blank line after the words "I have to-day inspected," and this the inspector fills out, giving first the class of structure and then the number. As I stated before, we can tell from our system of numbering to what class a structure belongs, but as the class is also given by the inspector each report shows on its face just what kind of a structure it is.

Mr. A. S. Markley.—On the general bridge inspection report blank shown in the report as used by the C. R. R. of New Jersey there is but one line to a bridge. It would be impossible for a man to write very much on that one line, especially with a blunt pencil in zero weather.

Mr. Sheldon.—I understood that each bridge should have a page instead of only one line.

Mr. Jutton.—As regards the spacing: One should economize space as much as possible, but if one cannot get it all on one line, he can take two. As regards the blunt pencils I would say that I keep a piece of sandpaper in the back of my book and keep my pencil sharp.

Mr. King.—On inspection trips on our road if we find a structure all right we simply call out "O. K." and go on to the next one. We do not do any writing when out on the line except to designate the structure on which there is anything needing attention and state what there is to do. Our records of bridges are all written up before we start out, and if there are any changes we so note them.

Mr. A. S. Markley.—I cannot quite see how one is going to make out a bill of material on the blanks that are shown in the report. We are, however, running the bridge inspection—that is, work simply to be done by the bridge inspector—together with the general inspection, which is entirely different. When we make an inspection we have the entire record, which is of great assistance to the inspector. If we have a bridge 20 to 25 years old we devote more time to it than one five or six years old.

Mr. King.—Our inspection is made only once a year, and unless a structure will continue without repairs more than a year we note it and the repairs are made. I see but very little difference in making more than one inspection if you know from that inspection that the structure will carry over another twelve months. Our trip is made in September and is a very careful one.

Mr. Jutton.—One inspection a year might be sufficient for a line that has almost all permanent work, but not where you have pile bridges, as it is impossible to say whether they will carry over a year or not. You must, on the one hand, keep on the safe side, and on the other you must not spend money unnecessarily. I think most roads require an estimate of the amount of money which is to be spent during the year. That means that you must make an inspection in order to compute that amount. In addition to this one must, if he wishes to follow up a bridge closely, have what we call "current inspection," and in that way, only, can the man who is responsible for the safety of the bridge, keep it so.

Mr. A. S. Markley.—I never could realize the necessity of sending a man out every thirty days to inspect bridges. A practical bridge man can tell in one inspection what will last over the next three months, and it looks to me as though inspecting a bridge every thirty days was uncalled for and is an unnecessary and extra precaution. It is true that the older the bridges the more frequently they should be inspected, but once per year should be sufficient until they begin to show decay.

Mr. Hadwen.—On the Chicago, Milwaukee & St. Paul Ry., in addition to the inspections that are made by the inspectors of pile bridges that are not permanent, there are also special inspections made of all bridges which are permanent. These are made by men from the general offices. The inspection reports show the bill of material necessary for any repairs needed. No inspection form blank is used with the regular field book, but the inspectors have with them a copy of the office records which they can check up, making notations of any changes which exist from the records.

President.—Is there any further discussion of this report?

There being no further discussion the session was adjourned.

III.

BEST ORGANIZATION FOR A RAILWAY BRIDGE AND BUILDING DEPARTMENT.

REPORT OF COMMITTEE.

To the American Railway Bridge and Building Association:

In the preparation of a plan of an organization that will be for the best interests of a Railway Bridge & Building Department, your committee has solicited the opinions and views of a large number of the members of this organization, which has materially assisted in outlining the plan submitted.

In preparing this plan we have kept in view the thought that the organization which will secure the best results for the railway company as a whole is the best organization for the B. & B. department; as the relations between the B. & B. and the road department are so close we believe the best results can be secured by having both under the same head.

We have prepared diagrams showing an organization suitable for railroads having 1000 miles or less, 3000 miles and 6000 miles of track. For a railroad having 1000 miles or less we have shown the head of the B. & B. department as chief engineer. To him report one or two supervisors who are in charge of the B. & B. foremen and water service men.

For a railroad having 3000 miles of track we have shown as B. & B. department head a chief engineer with an engineer B. & B. as a member of his staff, it being the duty of the staff officer to furnish plans and look after the execution of the work while the chief engineer directs the policy. Reporting to the chief engineer is an engineer maintenance of way, to whom six division engineers report, who in turn each have a supervisor of B. & B., who is in charge of the B. & B. foremen and water service men.

For a railroad having 6000 miles of track we believe the following organization will be very effective:

Chief engineer is the head with an engineer B. & B. as a member of his staff, to whom report a superintendent of bridges, superintendent of buildings, superintendent of water service, and supervisor of scales, each of these having two inspectors. Reporting directly to the chief engineer are two engineers maintenance of way, each having six division engineers and each division engineer having one supervisor of bridges and buildings who is in charge of the B. & B. foremen, water service and scale men, each B. & B. foreman having a district of about 125 track miles. Under each supervisor is a water service foreman with an assistant to look after all repairs to water

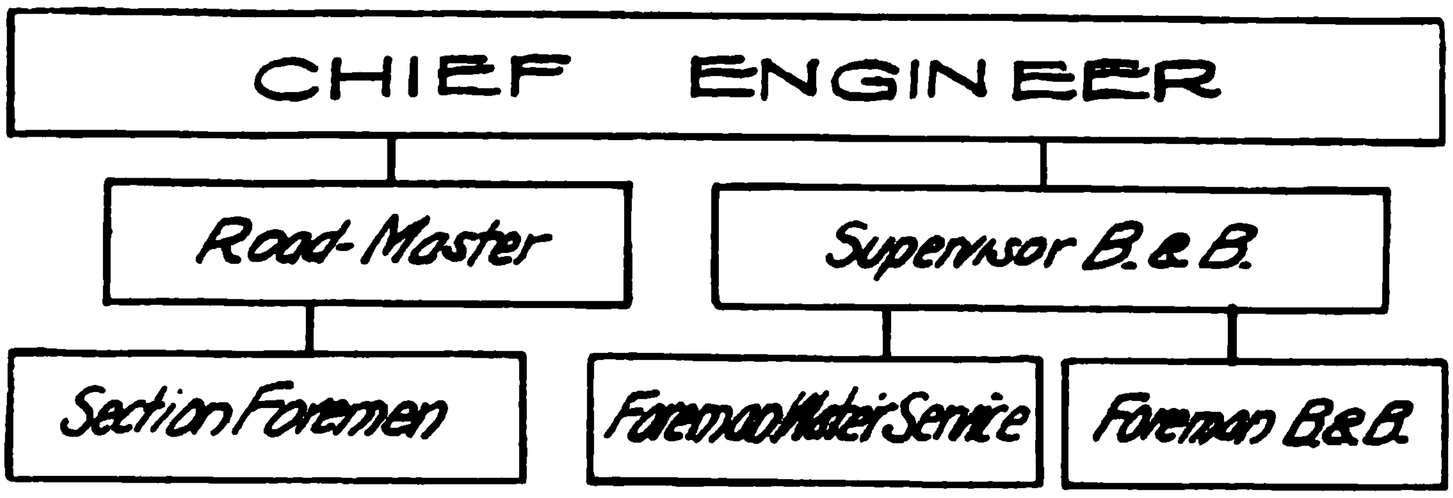


DIAGRAM NO. 1
PROPOSED
BRIDGE & BUILDING DEPT. ORGANIZATION
FOR A RAILROAD HAVING 1000 MILES OF TRACK

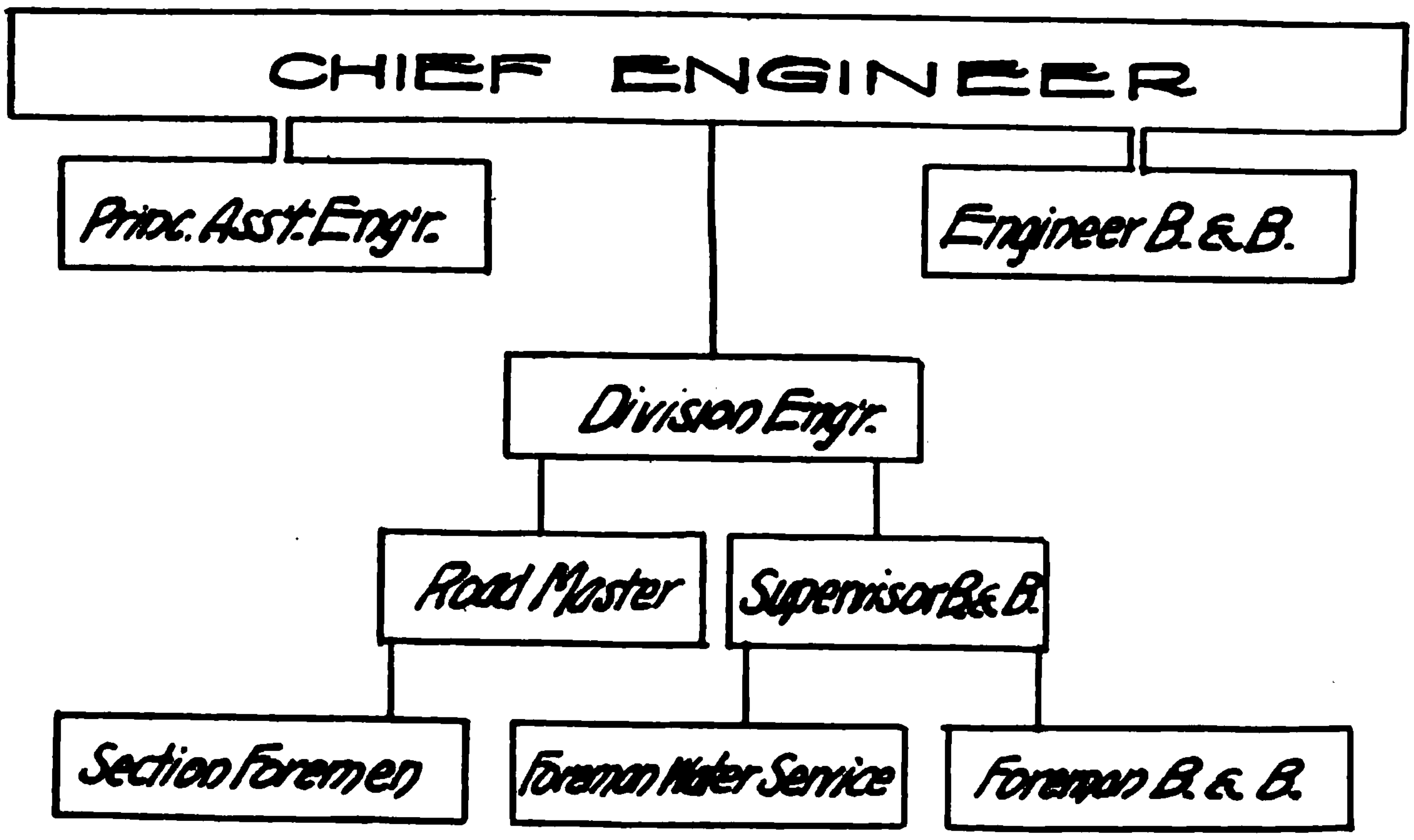


DIAGRAM NO. 2
PROPOSED
BRIDGE & BUILDING DEPT. ORGANIZATION
FOR A RAILROAD HAVING 3000 MILES OF TRACK

Diagram Showing Proposed Bridge & Building Department Organizations.

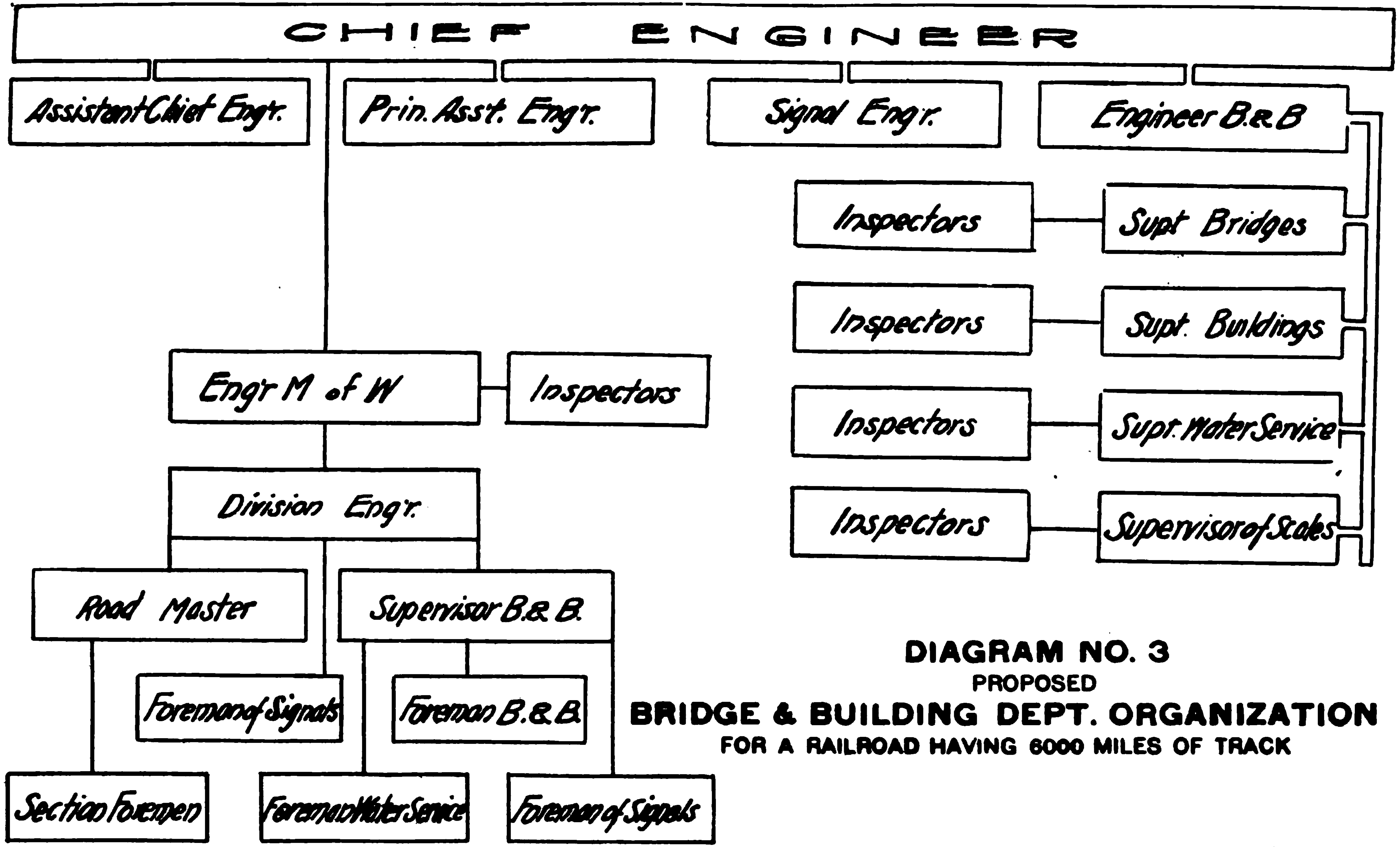


DIAGRAM NO. 3
PROPOSED
BRIDGE & BUILDING DEPT. ORGANIZATION
FOR A RAILROAD HAVING 6000 MILES OF TRACK

Proposed Bridge & Building Department Organization for a Railroad Having 6000 Miles of Track.

stations, and one thoroughly competent scale carpenter to look after all repairs to scales.

A road of this size should be properly equipped with sufficient tools to enable the superintendent of bridges to have a force in the field for the construction of culverts, masonry and erection of steel bridges.

The superintendent of buildings and superintendent of water service should also have sufficient force to handle all new work in their respective lines. This applies to new lines as well as existing ones.

On account of the local conditions it is impracticable to state any exact number of miles an organization will fit, but we believe a plan submitted with such variations as these conditions warrant will form the best organization for a railway bridge and building department.

F. B. Scheetz,
J. M. Wells,
W. B. Causey,
W. Hurst,
R. J. McKee,
Committee.

DISCUSSION.

Mr. A. S. Markley.—At the request of the chairman of this committee I sent him a letter some five pages in length explaining the organization on our road. I notice that it is not embodied in the advance copy of the report, which is very good as far as it goes, but it looks to me as though it was cut off before it had fully covered its scope. In order to get this before the members I would like to have my communication read to them.

President.—Will the assistant secretary please read this extra report.

The communication was accordingly read, being as follows:

" A good and efficient organization should consist of one man in charge of, and responsible for, the performance of the duties of the bridge and building department, whose title may be master carpenter, superintendent of bridges and buildings, or general foreman, over the territory assigned. which should not be less than three hundred nor more than one thousand miles of road. The office force should consist of one stenographer-clerk, and as many additional clerks as are required to meet the demands made on him originat-

ing from the superior accounting offices. He should maintain his own stock of supplies, throughout, for the maintenance of all structures in his territory, this to enable him to deliver any kind of material promptly at any point on his territory without the formality of several departmental heads signing requisitions before such material is accessible, thereby placing the responsibility for delay of material reaching its destination, on the person in immediate charge of the work instead of shifting it onto the storekeeper. The latter, either not being familiar with the importance of prompt shipment or not being advised of it, in many cases delays the work on the road, causing increased expenditure, and, in some cases, additional movement of men to other points to continue work until the delayed material arrives. This is also true in working off dead stock or odds and ends of material that the master carpenter has in his charge, which could not be done if the material was under the jurisdiction of the storekeeper, unless a list of such material was furnished periodically, so that the master carpenter might know what the storekeeper had in stock. A good, live man can at times catch three or four small jobs at one time, with one trip of men, when delays to material would require a trip for each job.

" There is no department on the railroad that requires such frequent shifting of men and material from place to place, and in many instances on very short notice, as in the bridge and building department. Men must go to the job with the material. For that reason the material should all be at the master carpenter's command.

" A liberal supply of good up-to-date tools and appliances should be supplied the men, more particularly those that are labor and strength saving. The gangs should also have good live foremen, who are constantly watching the men to prevent injury to persons and damage to trains and property, and who can distribute the men properly over the job, so that they are not in each other's way. Each gang of bridge men should consist of one foreman and six to ten men. For

general repairs the gang should not exceed that number. While engaged in rebuilding large structures, however, the number of men can be increased. In a gang of over twelve men an assistant foreman should be supplied. No gang should cover over two hundred miles of territory, and its headquarters should be at a main division point where all supplies are assembled and where the men should have their residences. The addresses of the men should be recorded in the office of the master carpenter so that all can be assembled on short notice. Under ordinary circumstances gangs of depot carpenters, stock pen and platform carpenters should not have over four or five men. Where there is a large job a corresponding increase in the number of men can be made, but no more men than can be handled to an advantage, and economically; and in the case of painters the gang should be small enough to allow paint to dry thoroughly before applying additional coats.

"The size of concrete gangs must be governed by the amount of work to be accomplished in a specific time. In addition to foreman and laborers, each gang should have one or two carpenters, to make forms, etc., and act as sub-foreman in handling the work. Each gang should have good, comfortable quarters to live in while on the road, supplied by the railroad company, consisting of dining car, sleeping car, tool car and an ordinary flat car for timber and other material carried in stock with the outfit. Cars should be equipped with necessary cooking utensils, which includes cooking and heating stoves, dishes, etc.; and a cook. In some camps one of the men is delegated to do the cooking. This matter is left to the men to decide. The men furnish their own bedding and eatables, the expense of living being divided between the men on the basis of the number of meals provided each one. The size and number of cars depend upon the number of men housed. Careful supervision should be made to see that the quarters are maintained in a neat, clean and wholesome condition.

"There should be one steam self-propelling pile driver for

each thousand miles of road, similar to those manufactured by the Industrial Works, Bay City, Mich. At each general headquarters there should also be one four-ton self-propelling steam derrick, with a fifty-foot boom for handling timber, etc. Each bridge gang should be supplied with passes for two of the most reliable men, good for self and three men, in addition to the pass supplied the foreman, so that gangs can be split up when occasions demand to make light repairs at different points.

"The men, more particularly those with a family, should be allowed the privilege of going home once a week to spend Sunday there. The very best of men desire this, and those who do not are hardly worthy of that name and are not the best associates or employees. Where men are away from home all the week they ought to be allowed to be there Sundays, if possible. Men should not be required to ride trains Saturday and Sunday nights to reach home and return to work. If so, they are not in condition to work Monday and do not have any pleasure or enjoyment while at home.

"The base of timber supplies should be at each bridge gang's headquarters, where the men reside, so that supplies can be loaded when they go home to spend Sunday. A six months' stock of all standard dimensions should be maintained. At the general headquarters where the master carpenter or superintendent of bridges and buildings lives one year's stock should be maintained, and with it an emergency stock sufficient to renew four or five hundred feet of trestle. This should not be allowed to get over two or three years old.

"Just how many men should be employed on five hundred or six thousand miles of road would depend upon the number of lineal feet of trestle to be maintained. Ordinarily, in the Middle West, one bridge gang of six men and a foreman ought to maintain bridges on one hundred fifty to two hundred miles of road. With two additional men they could also take care of stock pens and platforms. As the

mileage increases a corresponding increase in gangs is necessary, as well as substations for supplies and general headquarters supply. The latter should be maintained for five or six hundred miles of road.

" Timber should be piled on scaffolds, the top of which should be 3½ feet above top of rail, this to avoid rolling the timber up an incline to load it. When piled in this manner one or two men can load small lots of almost any of the standard size timbers, on a flat car, which would take several men to do if the timber was lying on the ground, on the same elevation as the track.

"At each master carpenter's or general headquarters a carpenter shop, about 50 by 100 feet, and 16 feet high, should be located. Of this shop a space 50 by 75 feet should be set aside for storing finished lumber and all other material likely to be stolen. The balance of this building should be finished for a shop for four or five men to work in, with brick floor, ceiled up, properly heated, and equipped with gasoline engine or electric motor, and such tools as combination crosscut and rip saw, mortising and boring machine, emery wheel and universal wood working machine, all power driven. With these appliances any building material or finished products required on any division can be gotten out, saving considerable expense of having it done by local factories or at car repairing shops. Delays are saved, as well as the time of men getting material to and from car shops, which is necessary in most cases where special material is required for repairs."

Mr. Lichty.—I will say that the committee received quite a number of reports similar to this, and the chairman wrote me that they had deceided not to publish them all, and for that reason I presume they did not include any of them.

Mr. Reid.—I presume that the gangs just mentioned as covering 150 to 200 miles of road, and getting home Saturday nights to spend Sundays with their families, must do both bridge and building work. Do they find it practicable to keep one gang always on one division and take care of all

kinds of work? We find it necessary to ship men from Buffalo to Chicago, and all over the road where work is to be done. I have tried to keep certain gangs on one part of the road, but have found it impossible to do this. We try, however, to let them go home as often as possible. In fact they really need to get home, not only to spend the time with their families, but to get clean clothes and attend to personal matters. That has been quite a question on the L. S. & M. S. Ry.—to keep the men as near home as possible and still take care of the work to best advantage. One cannot always pick up a bunch of mechanics whom it is safe to send out on the road, and for that reason we have to move our regular gangs from place to place, all over the road. It is a question worthy of considerable attention as to whether it is practicable to keep gangs on the division near their homes.

Mr. J. H. Markley.—I also sent Mr. Scheetz, the chairman of this committee, a report on this subject, including photographs showing exterior and interior of a combination tool, dining and sleeping car.

President.—Mr. Markley, would the equipment for a boarding car outfit come strictly under this subject, which is, "Best Organization for a Railway Bridge and Building Department"?

Mr. J. H. Markley.—I thought so. We feel very proud of the outfit I mentioned and I wished the report and photographs to appear.

Mr. A. S. Markley.—Here in the Middle West the problem of getting good bridge men is one that we will have to solve pretty soon. It is difficult to get good men, especially from the larger towns where they are paying a scale of from 40 to 65 cents an hour, to go out on the road for 25 to 27 cents an hour. On some of our territory, I am sorry to say, we have to keep men away from home at times for two weeks. We would like to get them home oftener. We wish to keep only the best men. and in order to do that we must divide up the territory, so as to give them less mileage to

cover, and in that way get them home over Sunday. It is different with help in localities where trains are more frequent and the territory shorter. I understand from one of the members that their men get home every night. We provide our men with all the advantages we can for cooking. Their meals do not cost them over 10 to 12 cents each, yet they live well and have the best there is for working men.

Mr. Sheldon.—Perhaps we are the exception, and it might not apply to very many roads in the country, but our train service is very frequent, our men are scattered at various places along the line, and at nearly all divisions they get home every night, and in that way we keep a better class of men than if we kept them out on the road. We do run boarding cars to a limited extent, but the men, as a rule, are scattered in gangs of four or five, and where the train service is the best we manage to get them out and in without very much loss of time. There is a recommendation in one of the papers in this report stating that a gang of five to six men take care of 150 to 200 miles of road. It would appear to me that this depends very largely on the number of bridges, and also on the volume of business, because it is known that if the traffic is dense our bridges go to pieces faster, and with us that is a very small number of men for that length of road. While the working day is somewhat curtailed by our allowing the men to get home every night we keep a superior class of men and they are in better shape to do good work.

Mr. A. S. Markley.—In reference to the matter of six men in a gang for 150 to 200 miles: We have a derrick car which is worth ten men; and, furthermore, where we have a small gang working we have the section men do the flagging, so that every man's work counts in the gang on bridge work.

Mr. Fake.—I would like to ask if any of those present have had experience with the use of motor cars for transporting their bridge men? I mention the subject in connection with the matter of allowing the men to get home. It

might be advantageous to have gasoline motor cars in some localities where they could be used for this purpose.

Mr. A. S. Markley.—Mr. Fake's suggestion in that direction is certainly a good one, and would overcome the difficulties to some extent. Bridge men are generally pretty bright men and good mechanics and could handle a motor car and keep it in repair. It will be but a short time until railroad managers will realize the usefulness of the motor car by bridge men, in going to and from their work, and distributing small amounts of material instead of stopping trains for the purpose.

Mr. Reid.—I have several small inspection motor cars like the Fairbanks "No. 2 J," and have assigned one of them to the foreman of a large gang of forty men who covers a territory of 150 miles, and where the bridges are pretty close together. The car will carry only three men, however, and he uses it in looking after fires and small special work. He can take a man or two with him and a few light tools and make light repairs, but I do not think that motor cars have been fully developed up to the point of transporting gangs of bridge men, I understand, however, that the manufacturers are working to accomplish this. Such a motor car should be big enough to carry quite a few men, and it should at the same time be so light that they can take it off the track on a minute's notice, and also replace it on the tracks easily. A motor car which has to be run on train schedule is not of very much use.

A motor car should also be dependable. Those now in use run very nicely for a little time, and then, without any apparent reason, the spark will stop and, try as you will, you cannot find out what the matter is. These are the occasions that get one disgusted with the gasoline motor car, and until we can get a car that can be depended upon I do not think that they are feasible for general use.

I was talking to the Fairbanks-Morse people here yesterday about some of these points, and I told them that I did not think they had perfected their car. The car should

be made lighter, so that it can be handled quickly, and the lighter it is the more carefully the men can take it off and replace it on the tracks, and the longer it will last. The general question of motor cars for the men is coming to the front, and I think it is only a matter of a short time until such a car will be perfected. One advantage over hand cars is that with the latter the men have to work their way to the job and are tired out when they get there, and where one can save time in getting the men to the work and also get them there in better condition it will not take long to save the first cost of a good motor car.

Mr. Richey.—I think this is entirely foreign to the subject, which should cover only the best organization of our department. What I would like to hear from the members is what gang or part of a gang makes certain repairs and to whom they report. Who takes care of their station platforms; who repairs mail cranes, stock pens, and on whose orders, and such questions as that.

Mr. A. S. Markley.—It is certainly a part of our organization and in line with the subject to discuss how to best get the men to their work and back to their homes.

President.—I would say that Mr. Richey's point is very well taken.

Mr. A. S. Markley.—I cannot see it that way. Boarding cars are part of the organization.

Mr. Reid.—I think the equipment and the question of motor cars and hand cars is necessarily part of the organization of the bridge and building department. They are part of the physical organization, and necessary to the work, and the discussion on these points is, I think, pertinent to the subject. The questions which Mr. Richey raises, however, are also pertinent and constitute a very important feature which has not been taken up very thoroughly in our previous discussions. We have skirted these questions several times, but I think the questions which Mr. Richey raises are still open, and that every member is very

much interested in them. Personally I would like to see these points thoroughly discussed.

Mr. A. S. Markley.—I would like to hear Mr. Richey's views on these points.

Mr. Richey.—I have for every ten miles, on our division, a man whom I call the "route man," and in this position I try out men for the position of foreman. That man is supposed to make a trip daily over the ten miles and make any small repairs necessary to station platforms, etc. He reports directly to the foreman and has no instructions whatever. These are his routine duties. The foremen do the large work, on orders direct from me. Emergency work is, of course, done when it is necessary without orders. I would like to know whether I can work up a better organization or system.

Mr. A. S. Markley.—That plan would probably be all right in some parts of the country where there is a good deal of work to do in a limited territory and where train service is frequent. In the spring we outline a program of everything to be done for the year, which is sent down to the master carpenter. Report is made to the division engineer on the 28th of each month as to what our men expect to do in the following month and also everything that has been accomplished in the current month. The estimate of work to be done is, of course, not followed out literally, but as nearly as it possibly can be. In short, we do the work by moving the men as little as possible, this question being left to the master carpenter, as to when and how except in cases of emergency. He, of course, keeps the heads of departments posted as to whether or not there are any changes to be made. Our bridge men repair all platforms, stock pens, windmills and such work as that, around stations. While they are doing the bridge work they have authority to make other such repairs as they go along, and thus avoid the necessity of sending out another gang for the purpose.

Mr. Ashby.—These diagrams seem to indicate the organization of your work along departmental lines, but what has

the committee done toward organization of bridge work under the divisional system? Assuming that the maintenance department is under the general manager, and it is presumably part of the operating department, since the cost of repairs would come under operating expenses, in what way has the bridge engineer jurisdiction over the bridge men? Who inspects for him, and what reports do they make? What I mean to get at is this: Where is the responsibility for keeping up current repairs if the bridge engineer is in charge of these structures? In what way can the bridge engineer give orders or recommendations? If he cannot give orders direct, how can he give orders and know that they will be followed out? Where is the working union between these two interests?

These diagrams are all right, as far as the departmental organization is concerned, but I believe that a modified divisional organization is a better one. Repair work is then done wholly by men under the general manager's department, these repairs being known as current repairs. In other words, the division superintendent is to have the superintendent of bridges and buildings making repairs only. When it comes to heavy renewals that is passed on to some one else, and that is a good thing. If there is a representative of the Norfolk & Western Ry. here I would like to hear from him.

Mr. Richey.—I believe we are getting beyond the scope of our organization. Our question is the reorganization of our own department in the manner in which we can get our work done to the best advantage, and I believe the committee has gone beyond itself in even suggesting anything as to the organization above our own department.

Mr. Ashby.—Will not the committee then express their ideas as to how they should handle the work, in what way they should inspect the structures and in what way suggest the repairs to be made? I do not agree with Mr. Richey in his statement that we should limit our suggestions to

changes in organization in our own department only. I think the committee should be in position to say what action or connection between departments should exist as far up as the bridge and building department is concerned.

Mr. A. S. Markley.—The information that Mr. Ashby asks for, as regards inspection and reports, was, I think, gone over pretty thoroughly yesterday in our discussion of our bridge inspection reports.

Mr. Andrews.—The discussion seems to be broadening out into lines in which the committee probably did not intend it to go. I think this subject applies to the practical work on bridges and buildings, and to get practical results we must commence at the beginning; and while the man who does the work has nothing to do with the general organization, yet it is necessary for him to know what that general organization is. We all know our own best, and we are probably all willing to profit by the best that the other man has. It is generally pretty hard to get permission to change to what you think is better until you can show that you will get better results.

In our own organization the position of bridge engineer is one of vital importance, and one that cannot fail to be recognized. At the head of the maintenance of way department we have the chief engineer of maintenance of way, who has entire control of all departments and of the standards, in maintenance of way. While he does not make those standards he has control of their application. The system is then divided up into grand divisions, each of these being further divided into divisions, at the head of which is a superintendent, who, in turn, has a division engineer. He has a track supervisor and a master carpenter.

Now when we reach the master carpenter we are getting down to what I understand to be the aim of this committee; that is, the organization of the working forces. The head of the construction department is the chief engineer, to whom the engineer of bridges reports. All matters of re-

newing and strengthening structures are handled through the office of the engineer of bridges. He either gets situation plans from the division people or through the office of the engineer of maintenance of way, and then makes plans for all men out on the road to make their inspection of the structures in question. He then makes drawings and forwards them to the chief engineer of maintenance of way, who, in turn, passes them to the general manager. If approved they are sent down through the regular channels to the master carpenter, who does the work.

It is the duty of the master carpenter, first, to see that all structures are kept safe under the traffic which passes over them. It is his duty to see that proper men are placed in charge of each piece of work, and to see that material is promptly supplied, or as soon as he can get it from the purchasing department, which is sometimes longer than he wishes. The master carpenter is, as I say, held fully responsible for the safety of his structures, buildings, platforms, water stations, material, crossings and every mechanical appliance that may come under the maintenance of way department. On completion of the work he reports it through the proper officers to the chief engineer and the engineer of bridges, the latter of whom then changes his sketches, forwarding revised sketches to all general officers who are concerned. The engineer of bridges has no authority to direct the master carpenter what to do unless he is on the road and finds defects. Then it is his duty to call the attention either of the engineer of maintenance of way, division engineer or master carpenter to the matter, who is supposed to attend to it, reporting back the action taken.

We feel that our organization is very good. It is a sort of a cross between the divisional and departmental systems. It works very well and puts it up to the master carpenter to keep his structures safe.

Mr. Richey.—This discussion brings it down to the master carpenter, and that is where I think it belongs. Mr. Andrews makes the statement that the master carpenter is

held responsible. What is his organization? That is what I want to know.

Mr. Andrews.—I have given you our general organization. As far as the organization of the master carpenter is concerned, perhaps it would be better for me to leave this to some of our master carpenters who are here, but possibly they will allow me to talk on this, because I was in that position for a number of years. The master carpenter has his bridge gangs, his house carpenter gangs, his water station gangs and his miscellaneous gangs to make general repairs. The bridge gangs are usually composed of eight men, the force being increased according to the work. If we have less than eight men we find that we cannot do effective work. The number of bridge gangs is, of course, proportioned to the amount of work to be done on the division. Some years we have considerably more work than others. We work strictly on the maintenance program. The program is made up in September of each year and forwarded to the general officers by October 1st. The general inspection is then made by the engineer of bridges and the inspector of maintenance, going over each division on cars provided for the purpose and stopping at each point named on the program for which repairs will be required during the coming year.

The program is made up giving a list of the different accounts for each structure to be repaired, proportioning the work to the total appropriation of money to be asked for. We make a close examination of the structures and decide in the field how much work shall be done. Nothing is cut off arbitrarily, and what is cut off is done after discussion. That is the preliminary program.

After this the accounts are tabulated and referred to the first vice-president and president for approval. We sometimes get the appropriation asked for, sometimes not, but we generally get enough to keep our structures in safe condition, by close watching. In addition to this the engineer of bridges, from the notes taken and the information fur-

nished, works up the renewal program, from which he is personally authorized to call for renewals of structures; and, if authority is given, he furnishes the necessary plans for large structures to the chief engineer, and for small structures to the engineer of maintenance of way, and outlines the work to be carried out by the master carpenter, whose duty it is to properly organize his gangs so as to do the most work possible. He has men for each class of work, and if he does not get good men to do it, it is partly his fault and partly the fault of the rate of wages that he can pay. We do, in a measure, get good men, because, as a rule, the work is steady. We have many old men on our rolls and they will be kept on until they die. They are faithful and efficient and take just as much interest in the work as the master carpenter.

President.—I would like to hear something said about the advisability of working the same or separate gangs on buildings and on bridges.

Mr. Andrews.—As a rule the ordinary bridge carpenter is not a good house carpenter, but a good house carpenter will make, in a short time, a most excellent bridge man. With us we have a very large amount of building work of almost every character, as we not only maintain buildings but also erect both small and large buildings. A bridge man on work of that kind is, as a rule, almost helpless. If you get a man who can do both kinds of work it is pretty safe to say that he does neither very well. I had one man who did all kinds of work, bridge carpentry, house carpentry, masonry, painting, etc., but I was not very proud of the way he did it. If you want good work done get men skilled in that kind of work.

Mr. A. S. Markley.—I do not quite agree with Mr. Andrews. In a bridge gang you will always find men who are skilled in various lines of work, and where there is a window light out or some other minor repairs we have the work done by our bridge gang, if near by, instead of sending men there specially to do the work.

Mr. Andrews.—I did not intend my remarks to cover patching work, but, as a general thing, to the more important work.

Mr. Clark.—I wish to supplement the remarks of Mr. Andrews a little on the line that Mr. Markley was bringing out. On my division where there is a window light out or such kind of minor repairs it is the work of the bridge inspector to attend to them. It is his duty, as he goes along the line, not only to inspect bridges, but also pay attention to the condition of depots, as to glass, windows, mail cranes, platforms and to make any light repairs necessary. If there is something too heavy for him to do he so reports to me, and I make other arrangements to take care of the matter; but any small defect, like putting on a lock or hinge, or putting in a pane of glass or adjusting a mail crane, he repairs as he goes along on his bridge inspection.

Mr. Richey.—I think that Mr. Clark has brought out the only point, so far as regards the organization I referred to. We have suits for damages on account of defects in platforms and Mr. Clark has brought out the only point applicable to the avoiding of such suits.

Mr. Clark.—I might say further that each foreman under my jurisdiction has a standing order to make all of these minor repairs without any instructions whatever from me. If he finds a plank broken in a platform he is to renew it without any special instructions. Of course, when it comes to rebuilding a platform or something of that kind he would have to get authority to do it.

Mr. A. S. Markley.—Particularly with reference to repairs of platforms, I would say that our agents protect that part of it, by reporting dangerous places, or nailing a board over a hole temporarily. No company can have a man all the time at a depot platform to inspect it, and oftentimes a plank might be broken within an hour after the inspector had passed.

Mr. Clark.—Our agents do the same thing; that is, they "half-sole" it, as you might say, with a piece of tin or

board. That is only temporary work, however, and the next time the inspector comes along he makes the permanent repairs.

President.—Gentlemen, we have given this subject as much discussion as we can probably afford, and, if agreeable, I will declare it closed.

IV.

WATER SUPPLY.

REPORT OF COMMITTEE.

To the American Railway Bridge and Building Association:

There is perhaps no problem in connection with the operation of a railroad of greater importance than that which pertains to its water supply. The problem pertaining to an individual station may be a simple one, while in others many serious difficulties may be encountered, depending mainly upon local conditions, the quality of the water being also taken into consideration.

The road which traverses a locality abounding with a good quality of water does not have to resort to drilling wells of a great depth, and then operating them at heavy expense or perhaps piping or hauling water for many miles.

Lakes and streams naturally furnish the best quality of water for boiler use, unless it contains organic matter, which if in excess causes it to foam; such impurities can not well be removed by any practical process.

Shallow wells furnish the next best supply, and, as the last resort, that furnished from deep wells, the latter as a general rule being more difficult to obtain and of poorer quality for boiler use.

Water purification has been quite elaborately touched upon in our Thirteenth Proceedings; hence it will not be considered at this time, suffice it to say that many roads are giving the matter considerable attention where the quality of the water can be improved.

When the source of supply has been determined the important question arises as to the best style of plant to be used for pumping and delivery. There is no doubt but that many roads fail at first to get a practical and economical system, for no other reason than that it may not be given due consideration by those best capable of judging which is the best apparatus to use for each specific case. It often happens that the practical man is not consulted at the time when the plant is designed and constructed, but he is often called upon later to remodel it or re-arrange it in such a manner as to make it do what is required, and to operate and maintain it at the minimum cost.

Pumping machinery and water supply material should be standardized as much as can be, for obvious reasons; it is not wise to have a great variety of apparatus doing like service on one division of a road, or in the same locality; this should apply not only to pumps, but windmills, tanks, tank fixtures, stand pipes and the like.

The subject of water supply in general has been given extensive consideration by the American Railway Engineering and Maintenance of Way Association in its 1909 Proceedings; most of our members can gain access to these Proceedings and will do well to

look them over carefully. Sufficient data are given to enable one to determine the relative merits for steam as compared with gasoline for the operation of a plant under certain conditions.

As a general rule, where a well is located within a reasonable distance from an existing steam plant, as at division headquarters, it is more economical to use steam for pumping than gasoline.

One phase of the subject which has been given little attention in the past, and is well worthy of investigation and consideration, is that of operating pumps by the use of motors, especially where the supply of water is easily obtained, and where the pumps must of necessity be located at some distance from the power plant.

This subject is too broad to be considered in its entirety in one report and the Committee would recommend that hereafter it be considered by subdivisions, as more thorough work can be accomplished by giving more attention to details; committees should be selected from the same localities in order that they can get together periodically and work in a systematic manner. By doing this, much useful data may be collected and compiled.

P. Swenson,
C. E. Thomas,
B. T. McIvers,
C. A. Lichty,
Committee.

APPENDIX.

LIST OF QUESTIONS.

1. What is the most economical method of pumping water from dug or shallow wells?
2. What is the best method of pumping from deen wells?
3. Give comparative cost of pumping by the use of steam and gasoline, and by the air lift process.
4. What kind of foundation do you use in setting gasoline engines?
5. Do you set gasoline engine over well, on one side of it, or some distance away?
6. What material do you consider best for pump house walls; concrete blocks or lumber?
7. Where water is poor, such as is found in North Dakota, do you think it advisable to use steam for power in pumping?
8. Are you using purifying plants; if so with what results?
9. Have you experienced trouble with freezing of stand pipe?
10. What kind of stand pipes do you consider to be the best?
11. What makes and sizes of stand pipes do you use?
12. How deep do you make the pits for stand pipes or water columns?
13. What kind of tank valve do you use, and what experience as to leaking?
14. Do you experience any trouble from outlet spouts freezing?
15. Do you use extension of inlet pipe above floor in tank?
16. What size of tank and kind of wood?
17. Any trouble from pipes freezing in frost proof box?

18. Please send drawing showing construction of tank and frost proofing.
19. What kind of tank foundation, and how constructed?
20. What make of windmill and size of wheel?
21. Make and size of pump for windmills?
22. Have you experienced difficulty from the operation of long discharge pipes?
23. Length and size of suction pipes.
24. Do you use rams? If so, name size and capacity, and kind of service rendered.

ANSWERS.

A. H. Hogeland, Chief Engineer, Great Northern Ry.:

1. All of our pumping is done with gasoline engines or windmills, except at some terminal points where either electric or steam power is used.
2. We pump from deep wells with gasoline engines.
3. We have never used air lift for pumping. We discontinued the use of steam pumps for pumping water some years ago, since which time we have used gasoline engines almost entirely, having found the same much more economical than steam.
4. We use both timber and concrete foundations, with a capstone, depending on conditions. If we are reasonably sure that the location will be permanent we usually use concrete.
5. In no case do we place the engine directly over the well. Where we use a geared base engine the same is placed partly over the well and supported on I beams. We do, however, when it is necessary to use a pump jack, place the pump jack directly over the well, supported either on I beams or timber.
6. Most of our pump houses are built of lumber. We have some fireproof pump houses, however, which are built of brick, with concrete roof.
7. The same answer as to question No. 3.
8. No. We have been able, so far, to overcome the difficulty of using very bad water by installing reservoirs dug into the natural ground, of a capacity of twenty or more million gallons, in which to store water collected from spring floods and melting snow.
9. No.
10. Same answer as to question No. 11.
11. We use Johnson, also Sheffield, 10 inch stand pipes.
12. Depends on climatic conditions.
13. We use our own design, which is practically the same as Fairbanks, Morse and Company's valve. We have not experienced any particular trouble on account of valve leaking and wasting water.
14. Yes, in extreme weather.
15. Only a slight extension.
16. We use 48,000 gallon tanks 16x24 feet and 100,000 gallon tanks 20x30 feet. Cedar and white pine staves and bottom.
17. Yes, occasionally in extreme weather.
18. Drawing furnished.
19. Depends on conditions. If the natural ground surface is

good we use footing stones; if there is any question, however, as to that, or if on newly filled ground, we use concrete piers.

20. Eclipse, 20 feet.

21. Curtis, also Eclipse, double acting pumps. Different sizes, depending on the amount of water required—3x12, 4x12, 5x16, 5x18, 6x18 and 8x24.

22. We have discharge pipes varying in length from a few feet up to six miles, and in size from four to ten inches. We have had no particular trouble with these long discharge lines, providing the placing of them was well done and they were operated under proper conditions.

23. We have no long suction pipes, it being the practice to avoid them, as it has been found that they are not satisfactory. The size of suction pipe depends upon conditions as to the amount of water, etc., required. It has become, in late years, the almost universal practice not to use smaller suction line than 6-inch.

24. No.

C. E. Thomas, General Foreman of Water Works, Illinois Central R. R.:

1. Taking everything into consideration it is the cheapest proposition to pump water from a dug, or shallow well, by means of gasoline as the power.

2. The most economical way of pumping water from deep wells, as far as the experience of this company is concerned is either by use of steam head or air, providing the water is not drawn from too great a depth, in which case it is not an economical way to lift water by air.

3. With us it is difficult to show any advantage of the gasoline supply to the steam or air lift, for the reason that the coal which we use at our pumping stations is obtained at a very low figure, being a cheap grade which is not used in manufacturing plants to any great extent.

4. We use concrete or brick for putting in foundations for gasoline engines.

5. Generally speaking, we put gasoline engines directly over wells, connected to a pump head or a double acting pump, located twelve to fourteen feet below engine.

6. We do not use anything but lumber in construction of our pump houses, but it is my opinion that concrete blocks or brick would be a decided improvement owing to the fact that it would practically eliminate the fire risk and in cold climates would greatly aid in keeping pump houses warm.

7. We do not operate in North Dakota.

8. We have ten treating plants in service and are getting very good results from them, having materially reduced engine failures as well as overtime paid trainmen and wages in labor paid boiler makers. We have shown a decrease of practically 90 per cent in engine failures since installation of treating plants.

9. We have no trouble in stand pipes freezing up.

10. On main line we use 12-inch stand pipes entirely, and in yards and around shops 8 and 10-inch.

11. We consider the stand pipe with drop spout the best for all purposes.

12. The standpipe pits are put in to a depth of 6 feet 6 inches with

exception of those south of the Ohio River, we put in only of sufficient depth to protect the valves and working parts.

13. Our tank valve is known as the Illinois Central standard.

14. We have no trouble with outlet spouts freezing, providing the tank valves close tight.

15. We have no extensions inside of tank above top of floor.

16. We use, on branch lines where there is no probability of any heavy increase in business, a 16x24 tank, but on our main lines we use a 20x30 tank on a steel sub-structure, bottom of tank being twenty feet above ground.

17. We do not have any trouble with pipes freezing inside of frost proofing of tanks.

18. For frost boxes in Iowa and Illinois, we use ⅞-inch matched material, with three one-inch air spaces, each air space being properly lined with tar felt.

19. We use Louisiana swamp cypress in construction of all water tanks.

20. A 16-foot air motor.

21. A 5x16 inch double acting pump.

22. We have several discharge lines, three to four miles in length and experience no trouble whatever in maintaining them. Our pipe lines of two miles or over are 8-inches in diameter.

23. The longest suction line we have is 800 feet and 8-inches in diameter.

24. We do not use rams of any kind.

Ed. Gagnon, Supervisor B. & B. Minneapolis & St. Louis R. R.:

1. Windmill and double acting pump 5x18 inches. If conditions for windmill are unfavorable, then use gasoline engine. A combination of the two will under certain conditions make an economical plant. In either case use a 5x18 inch double acting pump.

2. Use gasoline engine for power, with good and reasonable power to spare over and above that actually required. Deep well pump 5¾x24 inches being perhaps the most economical.

3. We use gasoline engines principally. Steam is used at division points where shop facilities are maintained and fire protection is necessary, requiring a high pressure at all times. In such cases the steam plants are unquestionably the most economical, steam being required for operation of mechanical devices anyway, and large quantities of water are used for various purposes, outside of that which is needed for locomotives.

Lifting water by air is probably the most costly method of supply, but may be used to advantage in case of several wells which are to be operated from one plant and where the distance water has to be raised is not too great. The saving in the operation and maintenance of pumps may offset to some extent the cost of air. We have three plants where we use compressed air to lift water. These are all located in South Dakota, where conditions are such that we were compelled to use it. An extreme case is where we bring the water up 650 feet through a three-inch pipe at the rate of forty gallons per minute, and every fifty gallons of water contains a quart of sand. As we have no other facilities at these points we get power from 40 h. p. gasoline engines in two

cases, and in the third we use a 25 h. p. gasoline engine. These plants are costly to install and expensive to operate and maintain.

4. Concrete foundations are used for all gasoline engines.

5. The pump house is located directly over the well and the gasoline engine just enough to one side to bring pump-pole and overhead connections in line, so as to maintain a direct pull on rods to prevent cutting of guides and packing. The engine is set on foundation 18 inches above the floor so as to clear the gear wheel; manhole in roof provides for pulling of pipe when necessary.

6. For pumphouse walls, I consider hollow concrete blocks preferable, but we use mostly wooden buildings.

7. Unable to answer.

8. We have not established any purifying plants on this system.

9. Have no trouble with stand pipes freezing up. Where water is supplied from lakes and streams it cannot of course always be prevented from freezing, but from deep wells there should be no trouble.

10. Our adopted standard stand pipe is Sheffield No. 8, ten-inch.

11. We use Sheffield 10-inch, and Poage 8-inch.

12. Stand pipe pits are constructed seven feet deep and covered with double floors.

13. We use 10-inch Eclipse tank valve and experience no trouble account of leaking. I consider there should exist no reason for a tank valve leaking if properly cared for.

14. In the northwest it is almost impossible not to have some trouble occasionally with outlet spouts freezing, more especially where the water is obtained from or near the surface and where only a few trains take water. Our locomotives are supplied with steam hose during the winter months and it only takes about five minutes to thaw outlet out if frozen.

15. We do not usually provide for an extension above floor inside of tank, but in the artesian basin in South Dakota we have some tanks with extensions inside, account of flowing wells carrying sand with the water.

16. Our standard tanks are cypress, 24-feet in diameter, staves 3-inches x 16 feet.

17. We experience no trouble with frozen pipes inside of frost boxes.

18. Frost box must be carefully and well made, all joints well covered including both top and base.

19. Present day tank foundation consists of the required number of concrete pedestals, 14 inches square on top, 4 feet x 4 feet at bottom and 4 feet high. (The depth of course will vary some according to the soil.)

20. We use Eclipse windmill with 20-foot wheel.

21. The pump used in connection with our windmills is the Eclipse 5x18 inches double acting.

22. We have no discharge pipes exceeding one-quarter of mile in length. We have one of that length which is 6 inches diameter, and it works satisfactorily.

23. We have no suction pipes of abnormal length.

24. Have no experience with rams.

In addition to reply to question 13, in regard to trouble with leaky valves I wish to state that in my opinion there is no excuse

—CAL—

Concrete Block Pump House, on Concrete Foundation, M., St. P. & S. S. M. Ry.

for them, if the pump man knows his business. There is a secret about this valve matter: First, valve should be put in right; holes for bolts to fasten valve to tank floor should be made 1-16 inch smaller (in lumber) than the bolt so it will drive tight and prevent leaking. Second, all bolts, pertaining to valve lever, should be made of brass, with a brass split through nut and bolt. The brass bolt costs a little more than iron, but they can be kept in good condition for ten or twelve years, according to my experience. Lever should have at least 1-16 inch play in all connections, so it will seat with perfect freedom. The valve rod should be arranged with brass bolts also; valve rod should be made with 1¼-inch gas pipe with solid jaws at both ends to fasten to valve lever to seat properly and the rod should always be set plumb. As to the lead seat, after it is worn out, I have it replaced with brass; this never wears out and is put on with pressure tight enough so it will not leak and it cannot be sprung or split with small articles which get into the valve. I always see that tank valve rubber is clamped tight so it will hold; sometimes when they are loose they will draw out with the suction when closing valve, account of the rubber being too small for the groove. In this case, set a rubber gasket over it to fit the washer plate, then bring down the set screw good and hard; this makes the relief washer valve grip tight so it cannot slip out.

We have sixty water tanks, and not one valve that is leaking. When I go over the line and find one leaking, which is very seldom, I get after the water man and get full particulars as to the cause; furthermore I do not allow chips, shavings, etc., to be left in the cornice of tank when built, as sometimes the tank may overflow and these chips will float out and be the cause of trouble. A water tank should be kept clean, and we have to go into them occasionally to see that they are clean. If these rules are carried out, there will be no trouble account of leaky tank valves.

P. Swenson, Supt. B. & B. Minneapolis, St. Paul & Sault Ste. Marie Ry.:

1. Combination of windmill and gasoline engine is the most economical, except at terminals where steam power is used for various purposes by the mechanical department.

2. Use of gasoline engine connected to a displacement plunger, deep well packing head and guided cross head.

3. We use gasoline engines. We have found them more economical than steam in repairs, fuel maintenance and fire protection.

4. Concrete foundation.

5. We put pump house and gasoline engine 16 feet from the well. In so doing we can place gasoline engine on concrete foundation, and if we wish to make repairs to the well or sink it deeper, it can be done without disturbing the gasoline engine or pump house.

6. We use hollow concrete blocks and brick; they keep pump house warm and eliminate the fire risk.

7. Gasoline engines are the most economical. If steam is used bad water causes the flues to leak in a very short time.

8. We have two purifying plants, and find them efficacious; they are expensive to install, but pay for themselves in a few years, by preventing leaky boilers.

9. Have no trouble in stand pipes freezing up.
10. We use Sheffield 10-inch improved direct acting automatic stand pipe with rigid spout fitted with anti-splashing nozzle.
11. There are several very good stand pipes on the market.
12. From 6 ft. to 9 ft. deep, built of concrete complete, including top.
13. Fairbanks, Morse and Co.
14. Have no trouble with spout freezing up.
15. Use 12-inch extension above floor inside of tank.
16. We use 16x24 foot tank with white pine staves.
17. No trouble with pipe freezing up inside of frost proofing of tank.
18. Of lumber and tarred paper, with air spaces between layers.
19. Concrete foundation.
20. (Blank.)
21. Use 4x12 and 5x18 Eclipse double acting pumps.
22. We have several discharge pipe lines, from one-half to a mile long; have no trouble with them.
23. We have one 6-inch suction pipe 600 ft. long, giving good satisfaction.
24. We do not use rams.

DISCUSSION.

President.—Mr. Swenson, the chairman of this committee, is not present. Mr. Thomas, you are on this committee. Have you anything to say in addition to what has been brought out by the report?

Mr. Thomas.—It might be advisable to have a general discussion on water service practice. You will note, however, that from the replies received by the chairman to his inquiries he has based his conclusion that shallow wells make the best water supply, so far as the character of the water is concerned. Now that might be true of certain sections of the country, but I think that the people operating south of the Ohio river find the contrary to be true; that is, that in almost all cases the water from deep wells is far superior to that obtained from shallow ones, while in the northern and western parts of the country the shallow wells seem to furnish the best quality of water. I know that on our own lines south of the Ohio river the water that we get from shallow wells is not of a quality that can be used in locomotive boilers, and for that reason we are going down to the second stratum, from which we obtain good water.

Mr. Dupree.—Referring to No. 10 of the list of questions sent out by Mr. Swenson. "What kind of a stand pipe do you consider best?" Now this is a pretty broad question. There are a good many kinds of stand pipes and they all claim to be the best. Of course that is up to us. As to No. 4, I consider concrete the best foundation on which to set gasoline engines.

As to No. 5, the way gasoline engines are constructed I see no danger in setting them over wells provided the gasoline supply is kept 30 feet away from the building. I cannot see any danger whatever if the pipe joints are well taken up. Question 13, with regard to leaky valves, is answered very well by Mr. Gagnon in the report. He states there that when a lead seat becomes worn out he replaces it with brass. A good deal could be said on these questions and I would like to hear some discussion.

Mr. C. A. Lichty.—Is not this subject of water supply continued for next year?

Mr. Thomas.—It is continued, but under a special head and particularly with the view of taking up the practice of the different roads as regards the best style and dimensions of hoops. Possibly it would be well to go on and complete the present discussion, because there will be a good deal of argument on the question of hoops which comes up for next year.

Mr. Moen.—If you have a little time I would like to hear some discussion now as to the advisability of using round or half-round iron for hoops.

President.—Gentlemen, our time is limited and that question will come up next year.

Mr. Smith (of Seaboard Air Line).—Further with reference to what Mr. Swenson had to say relative to the value of water from deep and shallow wells. On the Seaboard Air Line, south of Columbia, we have six flowing artesian wells which flow into our tanks and also have certain shallow wells. We find that the artesian water is strongly impregnated with minerals, while the only trouble with the

shallow water is tannic acid. We find the surface water best.

Mr. Dupree.—In my estimation the deep well is the poorest one, at its best, and makes work for everyone concerned. Therefore I think the shallow well best. In this report there is a picture of a pump house, and if I make it out right the dimensions are 14x14. It ought to be at least two to four feet longer. There should also be some way provided for blowing out the cylinders.

Mr. Fake.—Where we have deep wells we must have pump houses. I would like to suggest for further consideration, for another year, different methods of pumping from wells. The compressed air method is very simple and effective, although somewhat expensive.

Mr. Thomas.—I do not agree with Mr. Dupree. The shallow well is, of course, the best if you can secure from it the proper quality of water, but on our line I know that we cannot get good water near the surface, and for that reason we have to go down some 500 or 600 feet, and by so doing we can get good water and carry our locomotives 15 to 30 days between washouts. This is between Memphis and New Orleans. If we used water from shallow wells our locomotives would have to be washed out every three or four days, and, in addition to this, the flues would have to be replaced about every eight months, while, by using the water which we get from our deep wells they carry over from 18 months to two years.

Mr. Dupree.—There is a certain road in Illinois which crosses the Rock river, and they have driven a deep well within half a mile of this river in which an unlimited supply of water is available.

Mr. Thomas.—Is it the practice of the members to put in their own wells or have it done by contract? For ourselves we generally drive our own wells.

Mr. Smith.—The Seaboard Air Line has this work done by contract. I might further say that they case down to a depth which will carry them through the formations that

will not stand up. In one well in particular they went down 79 feet with the casing and drove then without casing 440 feet. In a well like this it is all right so long as the water is flowing, but if the pumping is stopped for four or five hours it is likely to cave in. Now that is the trouble in many cases in deep well pumping, where the water does not rise from the outside. If the well is cased all the way to the bottom, if a good, clean bottom can be found, it will hardly ever give any trouble. We had to abandon one well because the casing had not been carried low enough.

Mr. A. S. Markley.—On our line we have all this work done by contract because we have not enough of it to justify ourselves in keeping skilled men to do it. It is special work and requires men experienced in that line.

Mr. Staten.—We had a deep well drilled in the limestone country. They put it down 84 feet and found plenty of water, as we expected, but they thought it should go down further, so they put it down 400 feet, and started pumping it from the bottom. It came up as yellow and muddy as could be for a week or two and it looked as though we were not going to be able to use it at all. They sent me up there to make suggestions, and I started them pumping on the upper level. After they had pumped it two days and nights it cleared up and we commenced pumping it in our tanks and have used it ever since. Every once in awhile we will start pumping from the lower level, to keep it cleaned out, and it always comes up muddy and yellow.

V.

TURNTABLES: DESIGN, LENGTH AND POWER FOR OPERATING.

REPORT OF COMMITTEE.

To the American Railway Bridge and Building Association:

The committee appointed to report to the Association on Subject No. 5, begs leave to submit the following:

Early in the season the following circular was sent to members of the Association:

"The undersigned committee has been appointed to report to the Association on the subject of turntables. Kindly coöperate with the committee by sending to the Chairman any information that you may have on this important subject.

"The items below are noted merely as a general guide and we would urge that the information be given in as full and complete a manner as possible.

"TURNTABLES.

"1. Proper length, allowing for probable future increase in length of locomotives.
2. Plate girder tables, and cost.
3. Cast iron tables, and cost.
4. Gallows frame tables, and cost.
5. Other designs, and cost.
6. Foundation, circle wall, paving if any and pit drainage.
7. Power for operation; electricity, air and other power.

"Blue prints of standard plans will be very acceptable; if costs are given, it is requested that the amounts be divided as to material and labor as far as possible."

We are pleased to state that a very prompt response was made by most of the members and a number of these replies are submitted as forming the principal part of the report. A number of blue prints covering designs of tables, foundations, circle walls, etc., have been received, but they will not all be included in the report; some of the designs which seem to embody especially modern practice will appear in the illustrations.

The days of cast iron and gallows frame turntables are nearly past. There remain plate girder tables of both deck and through types. One member reports the use of a hinged type of Pratt design, the girders being hinged at center so that ends of table take their share of the load. This table is turned by means of a 45 H. P. electric motor.

Different designs of center foundations and circle walls are illustrated and described in the attached letters.

Statements and estimates of cost of complete installations of various sizes and types of tables will be found in the correspondence.

There are many points of interest regarding fastenings for both circle rails and track rails on coping walls which have been brought out in these replies from members. The committee hopes that a full discussion will be brought out on all these points. One detail which seems important, but which has been mentioned by but few members, is that of a recess in the circle wall for examination of the outside of truck wheels; one plan covering this detail is shown in our illustrations. It is a comparatively simple matter to provide such a recess and the opportunity to make examination of wheels is certainly a great convenience for making inspection and repairs.

Three kinds of power are in common use for operating turntables, namely, air, electricity and gasoline. Each has its advocates, and the different elements of loading on table, climatic conditions, frequency of turning, etc., all enter into the choice of any particular one.

The matter of cost of tables, including installation, operating devices, etc., has been reported on in many instances in great detail as a careful perusal of the letters from the members will show.

APPENDIX.

J. P. Canty, Boston & Maine R. R.:

Anticipating the probable length of a turntable required for future locomotive service, is rather an uncertain problem just at this period. However, it is the opinion of many that, on the division where I am located, the lately purchased steam locomotives have apparently reached their economical limits in both length and weight, provided the class of traffic remains similar to that which is now being handled.

The largest engines on our division are turned easily on turntables 70 feet long. This is now our standard length, and as far as we are able to predict, will answer for future requirements.

Although we have in use many turntables of different lengths and patterns, installed during the past thirty years, it seems that a report covering their design and cost would not be of any material benefit at the present time, excepting possibly from a historical standpoint, therefore, we will confine ourselves to a report on the latest pattern installed, that is the 70-foot table above mentioned.

The steel work in these tables cost approximately $2,500 on board cars delivered to our road by the contracting bridge company. It is perhaps needless for me to dilate on the details of the construction of the steel work, as there is nothing unusual about the design, being made similar to those used by many other roads, that is, the customary deck plate girder pattern. However, I will mention that we specify that four cast steel end wheels shall be furnished on each end of table and the center pivot bearing shall be of the disc pattern; meaning that the table turns on a composition disc on top of the center cast steel pivot casting, instead of on the familiar roller bearing.

Our turntable center foundations have, of late, been made of concrete, being ten feet by ten feet on bottom and bearing on piles when there is doubt about the earth being sufficiently solid to carry

the maximum load on this area without settling. The bottom course of concrete is generally two feet in depth. The foundation is then stepped to seven and one half feet square by two feet thick, and a granite cap five feet square by two feet in depth is placed on top to receive the cast steel center pedestal.

There are three hundred and thirty cubic yards of masonry in our 70-foot turntable pits. The whole outfit, including turning motor, costs us between $6,000 and $7,000. Figures vary for different locations, depending upon whether or not we are obliged to drive piles, provide expensive drainage, etc.

Practically all of these new outfits have been put in where older and smaller tables were installed and as the older tables were kept in service just as long as possible so as to avoid delays to engines, our work has always been made more expensive than if new tables were constructed where we would not be handicapped by keeping the old table in use.

We use gasoline power turning device.

The floors of the turntable pits are covered with a coal-tar concrete paving, about two and one-half inches thick, somewhat similar to that which is used extensively in small cities and towns in New England for sidewalk surfaces. This gives a fairly hard and elastic surface, and does not crack when soil underneath heaves with frost. It is comparatively smooth, so that it is easily kept clean and snow may be removed from pit without much trouble. The cost is about fifty cents per square yard.

H. A. Horning, Michigan Central R. R.:

For your report, if you care to use them, I will state my views in the matter pertaining particularly to service such as we have.

I prefer a deck steel-plate table, if the conditions are favorable for drainage, if not, a half-through table should be substituted. We are using tables of this kind 85 feet in length, but 90 feet would be better.

Great care must be taken relative to the depth of girder to prevent deflection, which is very detrimental to operation. The full load should be carried on the center, and conical rollers should be used instead of discs. The end bearings of table should have rollers instead of sliding plates. Center foundation should rest on natural rock, or piling, capped with suitable concrete block. Coping wall should be concrete on a suitable foundation, and capped with timber instead of curved rail. Pit should have cement floor and properly drained.

If possible electrical turning device should be supplied. If electricity cannot be had, gasoline is the next best method. Electric current for operating turntable should be brought in beneath the table, and the table should be well lighted.

In this territory we do not find it necessary to cover the pit.

A. H. Beard, Philadelphia & Reading Ry.:

As requested I herewith enclose two blue prints of turntables used by the P. & R. Ry Co., one 65-foot table and one standard 75-foot table.

The cost of a plate girder standard 75-foot table in place ready for the track rails is $7,785.00, as follows:

Masonry,	$2,500.00
Miscellaneous,	500.00
Table,	4,785.00
	$7,785.00

A 65-foot plate girder table has been in service at the roundhouse at Reading since 1897. This was manufactured by the Pottstown Bridge Company. Engines of all classes are turned on this table, the number turned every 24 hours (although the table is short for some engines) is 75 to 80. The cost of this table in place was $5,825.00.

This table at present is operated by an 8 horse power gasoline engine, manufactured by the Williamsport Gasoline Engine Company, the cost of same in place was a fraction over $1,000, and costs for operating about $165 per month, this includes labor, oil, gasoline and repairs. We are now arranging to install an electric motor on the same table to replace the gasoline engine.

The turntable referred to is in the roundhouse and the space will not admit a 75-foot table.

F. E. Schall, Lehigh Valley R. R.:

1. Eighty feet long.

2. Deck plate girders 5 feet 6¼ inches deep at center and 2 feet 8¼ inches at ends, spaced 6 feet center to center, conical wheel center bearings with live ring, built for a moving load of Cooper's E 50 engines or 4,500 lbs. per lineal foot of table. Cost about $3,200 delivered f. o. b. cars within 200 miles of bridge shop.

3. Cast iron turntables are out of date and not satisfactory for present loading.

4. Have no experience with gallows frame tables.

5. There are in use through plate girder turntables with steel floor system but we have none on our line, and therefore cannot give cost.

6. The center foundations and circular rim walls are generally of concrete, the circular rail resting on short sawed ties. The top of rim is covered by a white oak timber coping to act as a cushion with rail tie-plated. The pit is paved with concrete about 6 inches thick, and provided with drainage. For outlying districts, and tables not used extensively, the rim wall is at times omitted, using only a segmental wall at entrance and run-off of table, using ballast under the ties of circular rail.

7. For operation we have in use electric motors, gasoline engine motors and air motors; all are giving satisfaction. When electric power is at hand, it is the most suitable power to use; when electric current must be purchased from other parties or when none is available, gasoline engine motors of from 8 to 10 horse power will prove very satisfactory. The air motor will also prove efficient if properly installed and arranged to take proper adhesion on circular rail, obtaining a sufficient supply of air from locomotives to be turned, unless the air can be taken from a compressor near by. The air motor will not turn as many engines in a given time as either of the other two kinds, because of the time required in making couplings, but for outlying districts it is the best motor attachment available at this time. The cost of installing one of the motors ranges from $900 to $1,200.

Moses Burpee, Bangor & Aroostook R. R.:

1. I would think that 70 ft. length of turntable would be necessary for heavy locomotives for general use. Sometimes such length is necessary for cars, but usually it is not the length of wheel base which determines the length of turntable so much as their position in balancing on the table.

2. In one case a 70-ft. turntable installed, including masonry of foundation and ring, as well as drainage cost about $4,500.

3, 4 and 5. Do not use.

6. Usually find drainage of turntable necessary, and provide for it in all of our plans.

7. Do not as yet use any kind of power for operating.

A. A. Wolf, Chicago, Milwaukee & St. Paul Ry.:

1. We use 85-foot turntables on mountain division where the heaviest power is used, and 75-foot tables on other main line divisions.

2. We have three types of the plate girder tables, which we distinguish as through, semi-through and deck. The reason for these various designs is occasioned by the difficulty in many places of getting drainage from the pit to a sufficient depth to accommodate a deck table. These plate girder tables cost from $6,000 to $8,500, varying somewhat with local conditions, pertaining to the nature of foundations, etc. The labor amounts to from 35 to 40 per cent of the total cost.

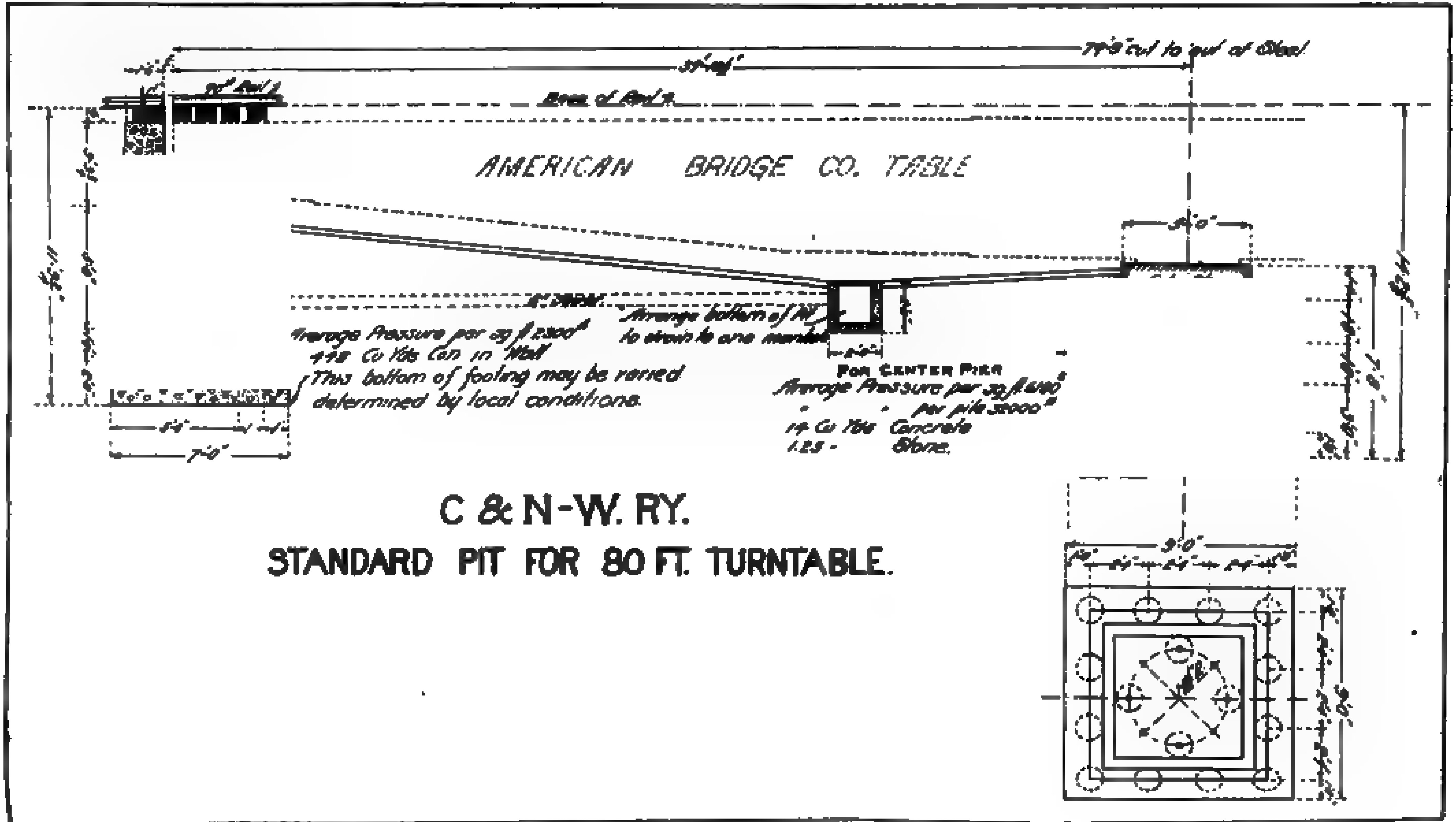
3. We have none of this kind.

4. None.

5. None.

6. For plate girder tables, we use a concrete center pier, circle wall and circle rail foundation; the circle wall and foundation for circle rail being of monolithic construction. Piles are always used under center foundation, except at places where solid ledge rock is found. Piling is used under circle wall except where rock or other firm soil is found. We do not make it a practice to pave the pits. Drainage is provided by means of connection to roundhouse sewer or to low adjacent ground, according to local conditions.

7. We use gasoline and electric motors, only for power. The



Standard Pit for 80-foot Turn Table, Chicago & North Western Ry

electric motor, in our estimation, furnishes the ideal power for turntable operation where it can be procured without excessive cost. At several of our division points we have our own generators and consequently the current required for operating turntable costs but very little.

I. O. Walker, Nashville, Chattanooga & St. Louis Ry.:

1. Our standard length is 70 feet.
2. Plate girder tables cost with ties, latches, etc., in place $3,200. Masonry and foundations $2,000. The cost of the masonry is extremely variable however.
3. Our cast iron tables with Greenleaf centers are very old and I do not think the cost could be secured.
4. We have only one gallows frame turntable in use. This was purchased some eighteen years ago during the construction of one of the branch lines and has been moved four times and rebuilt twice; original cost unknown. It is an exceedingly unsatisfactory table.
5. The three designs mentioned above are all that we have in use. We are doing away with turntables wherever we can, substituting "Y's" in place of them, even when the cost of right of way is considerable.
6. Foundations depend upon local conditions.
7. We have no power operated turntables on our road, although we have arranged openings for air connections to motors if we decide to use them.

W. T. Main, Chicago & North Western Ry.:

1. Turntables newly installed in the future should be 80 feet in length.
2. 70-foot King Bridge Co., deck plate girder turntable installed at Chicago Ave., in 1907 cost as follows:

Material,	$2,570.46
Labor,	2,262.00
Total,	$4,832.46

This table replaced an old 60-foot deck plate girder and was installed under continuous traffic except for two days while new concrete center pier was allowed to set. Over 400 engines were turned every 24 hours on old table during construction of new circle wall which will give some idea of conditions under which work was done and reason for high cost. Table is operated by 10 h. p. electric motor which was used on an old table but furnished with new frame. Our 70-ft. King Bridge Co., deck plate girder turntable installed in 1907 cost as follows:

Material,	$2,890.00
Labor.	2,490.00
Total,	$5,380.00

This table replaced an old 60-foot Lassig plate girder and was installed under traffic in same manner as the old one mentioned. About $500 of the cost was due to renewal of radial tracks. The circle wall was built of concrete and the center pier of concrete,

reinforced with scrap rails in order to spread the load over old masonry foundation. The table is operated by 10 h. p. Pilling air motor and has six reservoirs under runways, the air being furnished by a compressor.

3. Sixty-foot Stroebel deck plate girder table installed at Chicago Ave., in 1899 on old masonry wall and new center pier cost $2,520. Sixty-foot Greenleaf cast iron table installed at Milwaukee, 1899, including new center pier, cost $3,100; the table alone cost $1,160.

4. A 50-foot gallows frame turntable installed at Evanston in 1896 with timber circle wall and center pier cost $983.

5. Do not use other kinds.

6. Circle walls should preferably be built of concrete except when table is renewed under traffic, where rubble masonry can be used to better advantage while working in cramped space. Center pier may require pile foundation unless subsoil is good where a spread foundation of concrete or masonry 12-feet square will serve. The advantage of paving in pit will hardly justify the additional expense though it is easier to keep pit clean when paved and it helps the drainage. The best drainage possible should always be secured. Circle walls should have an offset at one point to allow of examination and repairs to end rollers and boxes, particularly where table has rollers between girders. Masonry circle rail seat should be extended at two points, diametrically opposite, to afford support for jacks for raising table and examining center. This saves placing cribbing on soft ground when using jacks and renders the operation much safer.

7. Would recommend the use of electric motor for operating table wherever possible and where service demands the quick handling of engines; second choice, gasoline engine; third choice air motor. The latter gives excellent service, where there is plenty of time for handling engines and where there is a sufficient supply of compressed air which can be piped to reservoirs, but it is slow in operation where engine to be turned must supply the air.

B. J. Swcatt, Contractor, Boone, Iowa:

1. For western railways using the larger type of locomotives, I do not consider that the length of table should be less than 75 feet, and 80 feet would be preferable, where the tendency is to an increase in the length of locomotives and tenders.

2. In my opinion plate girder tables are the best for general use, the deck type being the most satisfactory and also the most economical where drainage of the pit is practical. The cost will of course, depend on market value of iron, but will compare very favorably with any other type of table.

3. My experience with cast iron tables convinces me that they should never be used, except for lengths under 60 feet and then only where the traffic is very light. All of the cast iron tables with which I have had anything to do had to be reinforced with heavy iron truss rods and even when so strengthened they were very unsatisfactory. I have no data on the cost of this type of table.

4. Gallows frame tables are, or at least they should be, relegated to the scrap heap by any railway that can afford an iron table.

5. No experience with other designs.

6. The foundation for a table is in my opinion very important; piles should be driven in all cases where solid rock, hard clay or cemented gravel is not found. The piles for center foundation should be spaced not more than 36 inches apart and the number of piles should not be less than 20. Concrete is about the best, and at the same time the cheapest material that can be found on which to rest the center casting. The depth of this should be not less than four feet below the surface of the ground in the pit. The circle wall should have a good pile foundation, made of concrete, stone or vitrified brick; extending at least four feet below the surface of the pit. Turntable pits should always be paved, either with brick or an equal thickness of concrete.

Pit drainage is very important; the size of the drain should be not less than 6 inches in diameter and it should have a fall of not less than 2 inches in 100 feet. The inlet should be at a depth of one foot below the lowest part of the pit and should be provided with a good cast iron grating.

In countries where there is liability of snow storms, it is economical to provide a cover for the entire pit; unless this is done the cost of operation will be excessive and the delays in turning the power will be many. This covering can be made in sections of one inch boards and supported on a light frame work of timber or iron in such a manner as to be easily removed when not required.

7. Where electric power can be obtained at a reasonable rate, an electric motor should be used as it is not necessary to have an experienced man to run it and the cost of operating will be very small as compared with the loss of time of roundhouse men, extra help and the saving of time in turning.

A. O. Cunningham, Wabash R. R.:

1. Not less than 75 feet.

2. Deck tables of this length cost $2,600.

3. and 4. These styles of tables are out of date and should not be considered.

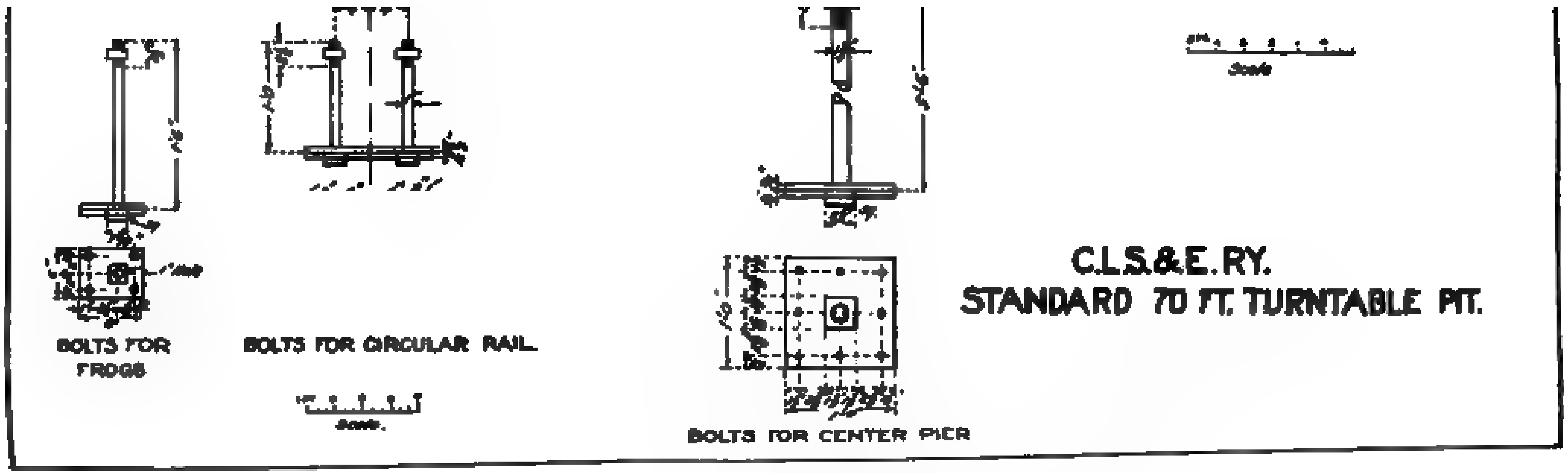
5. Do not know of any other designs.

6. Foundation of circular wall and paving should always be of concrete; pit should be well drained; the cost of this for 75-foot deck table would be $3,700.

7. Electricity is the ideal power for operating a table. If this cannot be obtained a gasoline engine may be employed of about 6 h. p. The cost of the electrical equipment would be $1,150, and for the gasoline engine equipment $1,000.

A. Montzheimer, Chicago, Lake Shore & Eastern Ry.:

There is no wood coping on the circle wall and no ties for the circle rail on a 70-foot table recently installed at Gary, Ind., which we consider sufficient for all future requirements. We used 150 lb. rail for the circle. The table is of Pratt design, the girders being hinged at the center so that the ends of the table take their share of the load. The table is turned by means of a 45 h. p electric motor.



Standard Pit for 70-foot Pratt Type Turntable, Chicago, Lake Shore & Eastern Ry.

W. H. Moore, New York, New Haven & Hartford R. R.:

1. The standard length for turntables on our road is 75 feet, but we build some tables 80 feet long.
2. The approximate average cost for a 75-foot deck plate girder turntable is about $3,500, and for a half through plate girder turntable about $5,750.
3. We do not use cast iron tables.
4. We do not now build any gallows frame tables except in rare instances for temporary use.
5. We use no designs except the plate girder type.
6. The cost of foundation of the circular wall, etc., varies so much, depending on the nature of the ground, that it would be hardly proper to name any average. I may say, however, that for a concrete pit with granolithic floor and granite center stone, in a location where there was good firm sand requiring no piles and where drainage could be cheaply taken care of, the total cost is about $3,800.
7. For power operation we use mostly gasoline motors; some air motors, and electric motors where current can be conveniently obtained. The cost of power installation averages about $1,000.

G. Aldrich, New York, New Haven & Hartford R. R.:

1. For the requirements of modern engines, 75-foot minimum; 80-foot recommended.
2. (a) 75-foot deck plate girder, erected complete $3,600, base of rail on table to top of center pier, 6 feet 4 inches; base of rail on table to top of circular rail, 4 feet 8 inches.
   (b) 75-foot through plate girder, cost with floor erected complete, $5,750. Base of rail on table to top of center pier, 3 feet 11 inches; base of rail to top of circular rail, 2 feet 9 inches.
3. Have not built any cast iron tables in the last 20 years.
4. Gallows frame tables built only for temporary use. Have no data as to cost.
5. The only designs we use are the plate girder tables.
6. The foundation, circular wall and center pier are constructed of concrete; the pit is usually paved with granolithic pavement. The cost varies in accordance with local conditions, ranging from $2,500 to $4,000.
7. For power we use:
   (a) Air supplied by the engine being turned.
   (b) Air supplied from compressors in adjacent shops.
   (c) Gasoline engines.
   (d) Electric motors.

Electric motors preferred where current is available; air motors supplied by compressors, second, and gasoline motors third choice. The cost of power installation varies from $900 to $1,200.

C. F. Loweth, Chicago, Milwaukee & St. Paul Ry.:

Your inquiries are so general that they are difficult to answer. The proper length of table will depend on the character of the road; the grades, traffic conditions and the like will influence in the size of locomotives. For instance: on our Pacific Coast extension, west of the central portion of Montana, we are using 85-foot tables, figuring that these will be of sufficient length to accom-

Standard 85-Foot Deck Turntable, Chicago, Milwaukee & St. Paul Ry

modate the mallet type locomotives, should we ever have occasion to use them on the several mountain divisions.

Between central Montana and the Missouri River we are using 80-foot tables, and the new ones on the old lines of our road are 75-foot.

The cost of tables you will readily appreciate will depend a great deal on the design and capacities for which they are designed, and especially on the centers, where there is perhaps more than the usual variation in design and strength, and consequently cost.

N. F. Helmers, Northern Pacific Ry.:

1. The Northern Pacific Ry. is installing 80 and 85-foot tables. I do not anticipate any power in the future which will call for the use of a larger table.

2. An 80-foot through table, without the circle rail, and weighing 114,855 lbs. cost in place $4,600. Such a table was installed at Staples, Minn., with concrete circle wall and center foundation. The masonry was done by contract, and the installation of the table by the company at an expense of $3.92 per ton. The framing of ties and other timber cost $4.05 per thousand feet.

The cost was as follows:

	Labor	Material
Turntable,	$ 211.44	$4,198.52
False work,		12.93
Timber, ties, planking, etc.,	35.23	77.49
Painting,	27.49	44.78
	$ 274.16	$4,333.72

Total cost (not including masonry), $4,607.88.

In 1908 an 80-foot table of the same type was installed at Minneapolis replacing one 64 feet in length. The foundation work was done under traffic, and the change of tables was done with a total interruption of 15 hours; itemized statement follows:

	Labor	Material
Excavation,	$ 463.94	
Gravel,	92.14	
Concrete work,	408.28	$ 651.52
Forms,	21.76	134.19
Circle rail,	38.74	
Table proper,	361.36	4,040.95
False work for curbing,		66.36
Removal of old brick curbing,	104.42	
Cleaning girders,	37.98	
Painting,	23.76	21.04
Ties and coping,	79.71	188.89
Engineering,		14.66
	$1,632.09	$5,117.61

Total cost, $6,749.70.

3. We have no cast iron tables.

4. We do not use gallows frame tables.

5. We have no other designs.

FOUNDATION WHEN PILES ARE USED

SCALE

Standard Pit and Masonry, for 80-Foot Turntable, Santa Fe, Coast Lines

6. I consider that ordinary conditions do not require the necessity of paving for the pit, but good drainage is essential in most cases.
7. For power we are using electricity and compressed air, while some of the 80 and 85-foot tables are being turned by hand.

Air motor in use at Jamestown, N. D., cost at St. Paul, $450; installation $19.81; total, $469.81.

Electric tractor furnished by Nichols and Bro., cost, $1,104.37; installation, $115.86; total, $1,220.23.

W. T. Powell, Colorado & Southern Ry.:

1. The up-to-date table should be 80 feet long, with a capacity for turning 200-ton engines.
2. We installed recently an 80-foot, 200 ton through-plate girder table which cost as follows:

Table f. o. b., Denver, including circle rails,	$3,700.00
Material for concrete foundations and walls,	1,090.00
Labor,	1,600.00
Total cost,	$6,390.00

This table replaced a 66-foot table and we were compelled to excavate and put in the curbing under 42 tracks and keep them safe while in use. We drove 24 piles for center foundation and capped it with a block of concrete 12 feet square and 4 feet thick; a deck table of this length and capacity would cost about $600 less.

3. We have some cast iron tables, but have no records of cost.
4. None.
5. None.
6. We use concrete entirely for masonry; rails are fastened with bolts and cast clips, the bolts being set in the concrete; no paving; drained when necessary.
7. We use air power with a two cylinder motor.

J. S. Browne, New York, New Haven & Hartford R. R.:

We have recently installed an 80-foot table at Providence. The center pier is of concrete, reinforced with steel rails, on account of the irregularity of the supporting material, as it was feared that the concrete might be fractured by the load if laid without reinforcement. The outer wall of the pit and the paving are also of concrete.

While an accurate record was not kept of the cost it was approximately as follows:

80-foot steel table delivered at Providence,	$3,400.00
Placing coping and circular rail and moving table into pit,	800.00
Concrete in outer wall and center, including forms,	2,800.00
Excavation, including disposal of material,	1,500.00
Paving,	300.00
Drain pipe to connect with sewer,	200.00
Total,	$9,000.00

The work was done by the company's force, and the high cost of excavation was due to the fact that a portion of the work was

done in freezing weather, and it was necessary to handle the material more than once before its final disposal by work trains.

The table has not been equipped with power, but a gasoline engine will probably be attached later.

The company's standard main line turntable is 75 feet long, but 80 feet is considered better at points where the largest type engines are turned, to permit of properly balancing them.

Deck plate girder tables are used where sufficient depth is available without excessive cost, but where this is not feasible, half through plate girder tables are used.

The superstructure of deck tables is about 30 per cent cheaper than that of half through tables, but this saving is balanced by the greater cost of the pit, so that under ordinary conditions the total cost of these two types is about equal.

Gasoline motors are generally used for power, although electric motors may be used to considerable extent in the future.

J. N. Penwell, Lake Erie & Western R. R.:

On our main line, we are taking out 62-foot tables and replacing with 80-foot tables, using the old ones on the branch lines. We have two of the old cast iron tables, 50 feet in length which have been in use 20 years, one of which is in perfect condition and the other about worn out. We have only one of the old style gallows frame tables, but it is out of date and will be replaced with a more modern structure within two years. For the foundation and circle walls we are using concrete. If foundation is not absolutely reliable, we drive piles. Drainage is important and the very best should be provided. Our tables are all operated by hand, except one which we are now operating with air. Would recommend electricity wherever it can be had. In erecting new tables we make provision for air pipes in the foundation, so that we can use air in the future if we desire.

W. F. Strouse, Asst. Engr. Baltimore & Ohio R. R.:

1. In 1907 I installed three Baltimore & Ohio R. R. standard 80-ft. plate girder turntables at Washington, D. C., in connection with the terminal improvements at that point. When the above standard was adopted this length was required to accommodate locomotives of the Pacific type, which were at that time being introduced into general use. These locomotives weighed about 230,000 pounds, the tender about 150,000 pounds, making a total weight of about 380,000 pounds, and an over-all length of 75 feet. With this margin no difficulty was experienced in shifting the locomotives to properly balance, thus carrying the greater portion of the load on the center instead of on the circular rail.

Since that time, however, the Mallet articulated type of compound locomotive has been introduced on a number of roads. It was first intended for use in helper service only, but now is likely to extend to road and freight service. The Mallet type in service on the B. & O. R. R. has an extreme length of about 80 feet. The locomotive in working order weighs 335,000 pounds, the tender 150,000 pounds, or a total weight of engine and tender of 485,000 pounds. The Southern Pacific Co. is said to have a Mallet type locomotive weighing 425,900 pounds, with a tender weighing 170,100 pounds, or a total

weight of engine and tender of 596,000 pounds. The wheel base of this locomotive and tender is 83 ft, 6 in., with an over-all length of about 92 ft. It is anticipated that this weight will be exceeded by that of locomotives now under construction. From the above it is not unreasonable to conclude that in the near future all roads adopting the Mallet type of engine will be obliged to construct turntables 90 to 100 feet in length. This will require, for operating reasons, a much stiffer table; otherwise too much weight will be thrown on the circular track, thus increasing the amount of power required for operation.

2. Two of the above tables were installed under favorable construction conditions, the bearing capacity of the soil being such as to require no unusual foundations. As work on both tables was carried on simultaneously and the conditions under which the work was done practically identical, the average cost only can be given, which is as follows:

Center pier, pit wall, paving and drainage,	$3,500
80-ft. plate girder table delivered,	2,120
Electric tractor in place,	1,360
Cross ties,	85
Circle rail with angle bars, bolts, etc.,	205
Lumber for floor,	40
Setting table on foundations,	500
Engineering,	140
Total,	$7,950

The third table installed in the vicinity of the main power house required unusual foundation construction. A portion of the site had been filled to a depth of about 15 feet, the space having previously been excavated to provide roadbed for a temporary Y-track. To insure safety in the center pier and avoid the possibility of cracks in the circle wall, 116 concrete piles, averaging in length about 25 feet, were driven. The cost of installing this table was as follows:

Center pier, pit wall, paving and drainage,	$6,920
80-ft. plate girder table delivered,	2,280
Electric tractor in place,	1,360
Cross ties,	85
Circle rail with angle bars, bolts, etc.,	205
Lumber for floor,	40
Setting table on foundations,	500
Engineering,	160
Total,	$11,550

In each of the above instances the item of cost of setting the table on the foundations covers the cost of work done by company's forces, including unloading the tables, placing the same into position, placing of the circle rail, putting on the ties and the rail, and flooring the deck of the table.

6. The center piers and circle walls in all instances were constructed of concrete and the pits were paved with a good quality of red paving brick, laid on about 2 inches of sand cushion, on natural

Electric Tractor on N. Y. C. & H. R. R. Turntable.

ground. Each pit is connected with a sewer by 6 inch drain pipe, drainage being collected by the proper grading of the floor of the pit to a common point where a catch basin is provided.

7. The power selected for the operation of turntables should be governed by local conditions. The tables above described were all
ed electrically. This form of power was de-
ll machinery about the plant is operated by
nsequence this form of power is always avail-
rate. Under the above conditions it is as
f, however, the power is taken from current
oses, air would be more economical, as the
to be operated much of the time at a loss.
supply can be obtained from the locomotive
should the compressor fail. A failure of the
er, puts the electric tractor out of commission.
to the use of air is the danger of pipes freez-
of course, is largely overcome by the use of

Electric Tractor.

ank.
tables were furnished by Geo.
n operator's cabin of structural
n electric motor geared to the
eel is mounted. The operator's
n forming a flexible connection.
wheel depends upon the weight-
tained in the same. The motors

tractor consists of two cylinders
e table. One end of the piston
haft of a spur gear, which con-
wheel. The tractive power of
y air pressure and is operated
ertically. By the application of
st a bracket on the table, which
in turn forces the traversing wheel hard against the rail.

A. W. Merrick,
H. A. Horning,
A. A. Wolf,
D. C. Zook,
T. J. Fullem,
Committee.

DISCUSSION.

Mr. Staten.—We have some turntables that are still strong enough, but are not of sufficient length, and we have extended them out. I would like to hear from some of the other members as to what arrangements they make to extend their tables. We spliced ours out with 100-lb. rails. It is probably not a very good thing to do but we have used it successfully.

Mr. A. S. Markley.—The length of the table is governed by local conditions. As for power for turning we have three different kinds; gasoline, electricity and air, the last named being supplied by the engine which is being turned. The vital point in turntable construction, as I think, is the foundation, and we have found that the only sure way is to drive piles, no matter what the surface conditions. As regards the question raised by Mr. Staten, I think the best way of lengthening tables is to buy a new, up-to-date table.

Mr. Large.—We have for some years had tables that were too short, and we simply took the wheels off and extended the girders at the ends by moving the trucks and tramway out. We have used them right along, extending with the same material as is used in the table. In this way we got several years' additional service out of them. The best way, generally speaking, is, I suppose, to buy a new table.

Mr. Aldrich.—In answer to Mr. Staten's remarks, we have two different methods. One is by letting the rail extend out from the table six or eight inches; and another way is by having a dog hooked onto the rail, so as to extend out. We find both of them unsatisfactory. The general opinion is that a new 80-ft. turntable will do better work. The old tables are not equal to the work and cause a good deal of trouble.

Mr. Richey.—I find in the report various costs given on the installation of new tables. I think there should be some idea given as to the approximate general cost.

Mr. King.—If a table is short, so that it must be extended only six inches, it seems to me that we are going to have trouble with it. I have found that a table works easier if we have considerable room on each of the ends. I believe the members will agree with me on that question. With hand power it is almost impossible to use a short table at all if you do not have the engine on the center.

Mr. O'Neill.—I think that, perhaps, the information the member wanted as to extension of tables had reference to cases where it was necessary once in a while to turn something longer than usual, such as a private car or something of that kind on a branch line. For instance, if one has a short table and no " Y " and must provide some way of accomplishing the result. We have used for this purpose a steel bar set right on the rail and long enough so that one wheel of a truck would be on the outer end of this and the other wheel on the part on top of the rail, to hold it down. In this manner we have succeeded in turning coaches or inspection cars on short tables. It is only a makeshift, but it answers the purpose.

VI.

DESIGN OF MATERIAL YARDS, PLATFORMS AND SHEDS.

REPORT OF COMMITTEE.

To the American Railway Bridge and Building Associatwn:

This report is extended only to material yards, platforms and sheds in the bridge and building department. In order to secure data for this report, one hundred and ten circular letters were sent to members, and as a result twelve replies were received. Being somewhat disappointed in the number of answers received, we do not wish to recommend any specific design or layout. We do not wish to censure the members for lack of interest in the subject, but we realize that the facilities and appliances for housing and caring for material in this department are of a provisional character and governed solely by conditions. For instance, we note from the replies received that on six roads the bridge and building departments handle and care for their respective material, two are operated jointly with the maintenance of way department and four by the storehouse or supply system. Hence the committee deems it advisable to give a summary of the replies and hopes that the discussion at the convention will develop an interest in the subject.

EXTRACTS FROM REPLIES.

J. P. Canty, Supervisor B. & B., Boston & Maine R. R.:

Our principal material yard is located at the headquarters of the division maintenance of way department, but we have two other smaller material yards at sub-division points for emergencies and general convenience.

The ground areas, tracks and buildings at the above mentioned points, used for the storage of material, were not originally designed for maintenance of way purposes and are, therefore, not well adapted for our needs. On many of the older eastern roads, as with us, quarters for these outfits are small shops, or portions of the same, abandoned by the mechanical department. We have nothing to offer as examples of efficient layouts for the economical handling of maintenance of way material.

All of our material is either handled directly by hand or by hand power boom derricks as is convenient. The greater portion of our material for bridge and building work is handled in a yard used jointly with the track maintenance of way forces and is under the supervision of a maintenance of way storekeeper.

H. H. Eggleston, Supt. B. & B., Toledo, St. Louis & Western R. R.:

Bridge and building material is placed together in our supply yards where we have a track through the center and the material piled on both sides on scaffolds the height of the floor of a flat car. Our water supply stock is all kept together in a shed and in the water supply tool cars on the line for emergency use. Our interlocking and signal material is all kept in the supply cars with the gang. Our painting supplies are kept in the tool cars with the painting crew.

We have a small supply yard at headquarters with one track in the center, and platforms, lumber sheds, etc., on both sides of the track. Material is all handled by hand power, except in unloading heavy cast iron pipes, when we sometimes use the wrecking derrick.

Sheds for storing lumber should be built of cheap material and covered with prepared roofing. Bridge and building material is handled under the jurisdiction of the superintendent of bridges and buildings. We maintain a carpenter shop without power.

G. Aldrich, Supervisor New York, New Haven & Hartford R. R.:

We have no special design for yards and tracks. All of our material is handled by a general storekeeper assisted by district storekeepers, with stores located at different points on the road. Our light material is taken care of wholly by these storekeepers and we order from them as we need it. Our heavy material, which is classified as lumber, heavy cast iron pipe, standpipes, etc., is kept at headquarters on our various divisions.

In my particular case we have one yard which is near my headquarters where we carry most of the material which is kept in stock, carrying only a very small portion where the different gangs are located. We load and unload our material by hand unless the steam derrick should be in operation when needed.

R. H. Reid, Supervisor of Bridges, Lake Shore & Michigan Southern Ry.:

Materials handled:—Timber, piles, bolts, spikes, iron pipe, tools and general bridge supplies. Timber should be classified for size, length and kind, that is, whether pine, oak, or fir, etc., and whether new, good second hand, or old.

On the Lake Shore we have two general material yards where we keep a good supply of material used in ordinary bridge and trestle construction and maintenance.

After the location of material yard has been decided upon, tracks should be built through the yard about 40 feet apart, and parallel to each other, and if practicable straight, with switch connections at each end so that cars can be taken in or out at either end. I would have them approximately 40 feet apart in order to allow timber to be piled on both sides of the tracks, so as to make use of the space to the best advantage. The piles of timber should be kept at least 5 feet from the rails of the track, to avoid injury to men on the sides of cars, and also to permit passage way between cars and timber piles. The material piles should also be about 4 or 5 feet apart, to allow passage way between them, and to furnish greater safety in case of fire. Piling, when kept in stock,

should be on elevated docks, where they can be rolled quickly from the pile dock onto the cars with the minimum expense, and when practicable, it is desired to unload piling on one side of the dock and load them from the other, so as to work off the older piles first, thus not to bury them under new ones.

Different lengths of piling should be kept separate, varying by about 5-foot lengths, that is, one pile might contain stock from 28 to 32 feet in length, another from 33 to 37 feet, etc. If only a very small stock is to be carried a greater variety of lengths might be kept in one pile.

The size of the yard would depend on the variety of sizes and amount of stock to be carried.

R. J. McKee, Supervisor B. & B., Illinois Central R. R.:

Prior to one year ago each division on this road ordered and took care of its own material and we carried a sufficient amount of material to build one or two small depots, and the running repairs of the division, and enough bridge material to build from 500 to 600 feet of trestle. This material was kept at division headquarters, with small houses and sheds to take care of the building material, and each kind of material was piled separately, under cover. The bridge material was piled on skids along a track that was put in for that purpose, each kind piled separate, and generally all of it handled by hand, which costs from fifty cents to one dollar per thousand for handling. I do not consider it necessary to build platforms upon which to pile lumber, as they are quite expensive, and do not materially lessen the cost of handling. The shed should be substantially built, with a good roof; anything to keep the lumber dry will answer. Our present system of handling bridge and building material is through the supply department, which has supply yards at different points on the system.

W. T. Powell, Supt. B. & B., Colorado & Southern Ry.:

Our material yards are located at division points. At these places we have emergency cars loaded with sufficient stock to rebuild an ordinary 80-foot trestle. These cars are always ready to go to a washout or burnout.

We have one building which contains office, carpenter shop and two store rooms, one for bolts, nails and heavy hardware, and the other for builders' hardware and pump supplies. In line with this building we have a covered shed, 100 feet long, in which we keep finishing lumber. There are tracks on each side of this building. We also have tracks on each side of our heavy material.

All material is handled by hand except the very heaviest, which is handled by the yard track derrick, which is self propelling and capable of handling five cars at a time.

Our sheds are boarded up on north side and the ends. They have no floors. Our platforms are elevated. All bridge and building material is handled by the bridge and building department.

A. A. Wolf, Chicago, Milwaukee & St. Paul Ry.:

On each division is kept, at the most convenient point, a small amount of material for emergency use. For the entire system a general stock is carried in the central yard for distribution to any

point where needed. A large percentage of lumber, timber and piling is delivered from the mills or forests direct to the point where it is to be used, and consequently is not handled through the supply yard.

As only a small amount of material is handled through our local division yards, we do not require any particular arrangement of tracks; usually a small space of ground convenient to some already established side track serves the purpose.

Timber, piling and light steel are handled by hand, except at the central yard where an industrial crane is in use to take care of everything that can be readily handled by two or three men.

We have locally on divisions no regularly maintained carpenter shop, but we have a small building where a local crew can repair or make small articles by hand, as needed on the division. We have at the central supply yard a mill equipped with machinery to surface any size material, resaw lumber, make siding, flooring, mouldings of all kinds, and in fact do almost any kind of work that can be done at the average planing mill. Besides, at this mill are framed wooden turn tables, Howe trusses, windmill towers and other kindred structures. The machinery in the mill is operated entirely by electric motors and is divided into several units, so that electric current is used only when each individual unit is in operation.

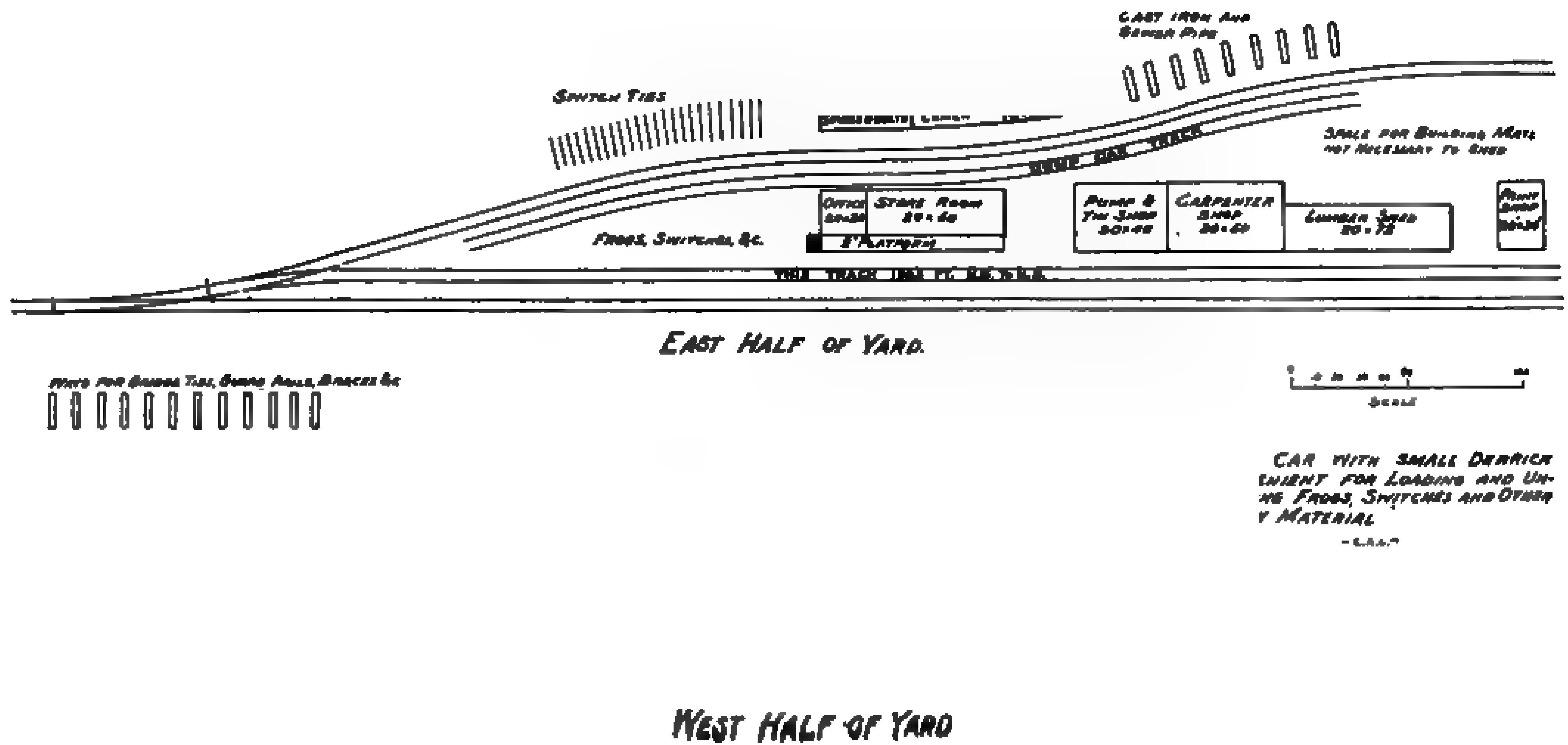
R. J. Bruce, Supt. Buildings, Missouri Pacific Ry.:

On our system everything in the maintenance of way department is handled at the same place, each division having a maintenance of way storekeeper, who reports to the division engineer, consequently the enclosed plan of proposed material yard would meet our requirements, while perhaps on some roads where the bridge and building material is kept separate from that of the track department it might not be entirely satisfactory. In planning any kind of material yard several things enter into it: generally, economy in handling material, along with convenience, is the first desire; economy of structures and fire proofing second.

We have on each division a storeroom and work shop, not especially arranged, for all was, as is usual, added to some nucleus already existing, rather than carrying out a well defined scheme from the ground up. We are, however, constantly improving along these lines, as a well equipped shop and yard soon demonstrates the benefits to be derived from them and encourages the management to more liberal allowances for such improvements, for it can not be expected that money will be spent on something that will not bring in returns by saving in labor and increasing output at the same time.

A. S. Markley, Master Carpenter, Chicago & Eastern Illinois R. R.:

We have no special design of yard or location of tracks. At each division point, one side track along the main track is made use of, from which to unload material. At the general yard, where a large supply and emergency supply is maintained (which is located at the headquarters of the master carpenter), one track along the main track and another 40 feet distant are used to unload timber and piling from, the latter being kept separate at one end



Proposed Layout for Maintenance of Way Yard, Mo. Pac. Ry.

of the yard, in piles, according to kind of wood and length; no piling is kept at the division points.

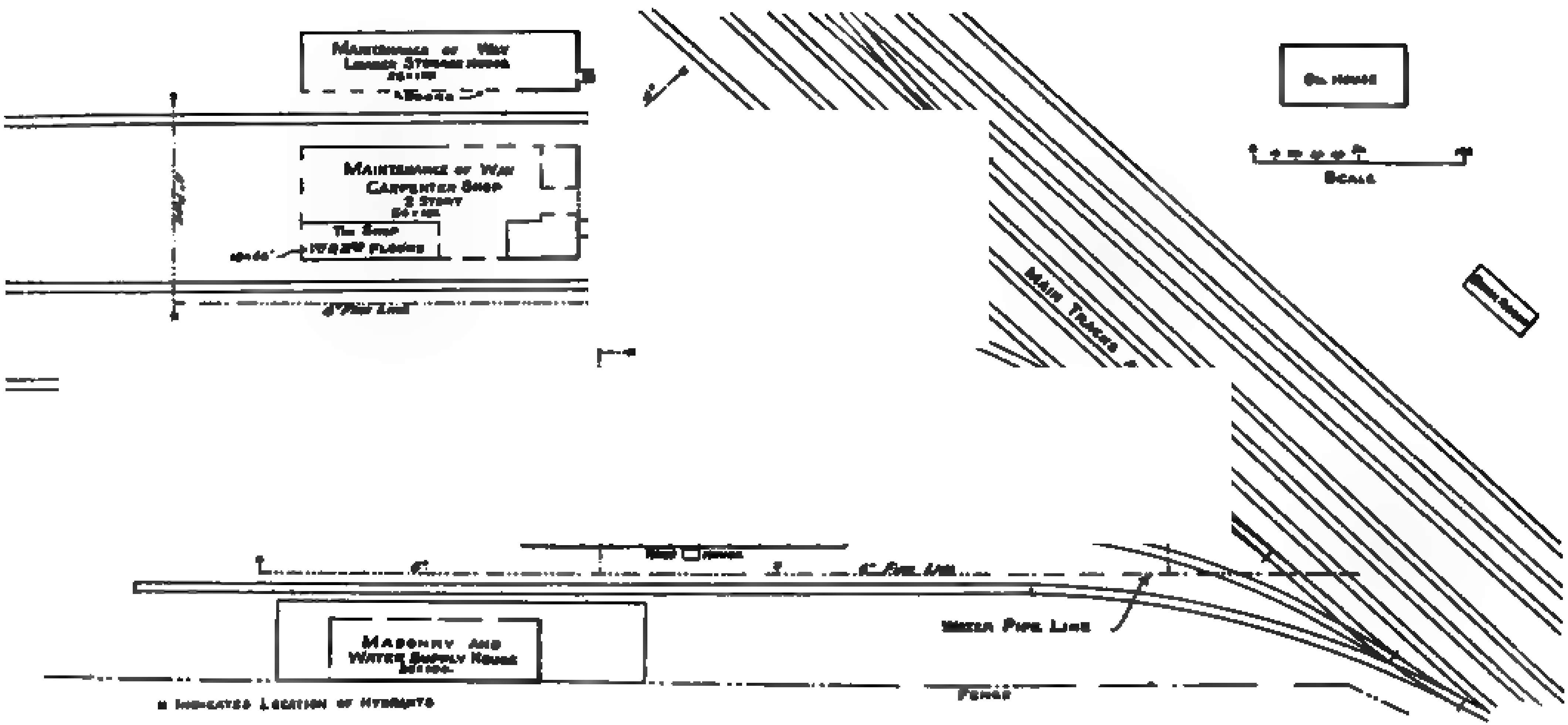
We have a self-propelling derrick car for handling material in the general yard. Unless there is a great deal of it, the loading at the division points is done by hand, but if occasion requires the derrick is sent to assist. The cost of handling, loading and unloading with the derrick varies from 85 cents to $1.50 per thousand feet. Where derrick car is used we put down old timbers for skidways, which are placed 10 or 12 inches above the ground upon which to pile timber and piling. Where timber is moved by hand old timbers are placed on pile heads three feet above head of rail, and spaced to accommodate the different lengths. These should extend back from the track 30 to 40 feet. All layers should have 1 to 3 inch strips between them, with timbers placed one inch apart, all piled even at one end and parallel with the track. The entire surface of the ground should be well drained and covered with cinders to prevent weeds from growing. A small house should be provided to shelter men, and store tools used in loading and unloading, in case buildings are not in close proximity to the yard.

The character and size of shed depends on the amount of material to be cared for. For 400 or 500 miles of road a building 50x100 feet, and 20 feet high, with track in center, is sufficient. A floor is not necessary. Lumber should be piled at right angles to track. A second scaffold should be provided at a height of 12 feet upon which to pile light lumber, sash, doors and the like. Thirty feet of one end of this building should be used for a workshop; to have an abundance of windows, heated with steam, if possible, and a brick floor; work benches around outer walls, and racks overhead for storing moulding, furniture, etc. The workshop should be equipped with an 8 horse power gasoline engine, universal wood-working machine, rip-saw, mortising and boring machine, drill, emery wheel and grindstone; with this equipment any ordinary work can be turned out quickly and economically.

Lumber, timber and a small quantity of hardware are handled on our road by the bridge and building department, under the direction of the master carpenter.

G. H. Soles, Supt. B. & B., Pittsburg & Lake Erie R. R.:

The accompanying illustration shows our layout of tracks and buildings. Lumber is piled as to sizes, the larger sizes close to tracks for convenience in handling. We use no power. All material handled by laborers. We have a double decked storage house, 28x132 feet, in which all shop lumber is stored. On the north side of this building there is a platform as high as the deck of a car, where we build all small buildings that can be transported on a car. We find this to be a good feature as buildings can be easily loaded when ready to send out. About 30 feet east of this is located the two story carpenter shop, 54x132 feet, the first floor of which is divided off into office for foreman, storeroom and tin shop; there is also on this floor a 30 h. p. electric motor, planer, rip and cut-off saws, drilling machine, etc. The second floor contains the carpenter shop and on this floor is installed a 25 h. p. electric motor, operating universal wood worker, small planer, band saw, turning lathes, rip and cut-off saws, tenoning and moulding machine. North of this, and 50 feet distant there is a two-story paint shop, connected by a bridge with the second story of



Maintenance of Way Buildings and Yard, P. & L. E. R. R. McKees Rocks, Pa

carpenter shop, and midway on this bridge there is an elevator large enough to accommodate large stationery cases, and office furniture. The first floor and cemented cellar of paint shop are used for the storage of paint and other material, and the second floor for painting. This yard also contains the water supply store house, shop and office, and the maintenance of way store house and yard.

All bridge and building material is handled by the bridge and building department.

A. Montzheimer, Chief Engineer Elgin, Joliet & Eastern Ry.:

The best design, in my estimation, for a platform for any use is one made of concrete retaining walls, cinder fill and concrete floor. Where heavy trucking is to be done on platforms, if the floor is made 5 or 6 inches thick and given at least 3/4 inch of rich top dressing it will stand up under any sort of trucking. This is the style of platform that we put in at Gary storehouse, also for the floor inside of the house. This floor is holding up in first-class shape.

I think that the best construction for sheds for material storage are those which are built with one side open, so that material can be loaded and unloaded without being handled through doors. This, of course, refers only to lumber. The building for cement should be closed in, and provided with windows and doors.

We maintain two carpenter shops, one at Gary and the other at East Joliet. These are one story and contain about 1,000 square feet of floor space, each. They are not equipped with power on account of being located at the terminals which have car shops equipped with wood-working machinery of all kinds. It would be a great saving of time if these carpenter shops were furnished with a small saw and wood-working machine, operated by an electric motor.

D. L. McKee,
Chairman.

DISCUSSION.

President.—No doubt most of you have makeshifts with regard to your yards and platforms, but have some ideals in your mind as to what you should have.

Mr. Hadwen.—In this report a concrete curb for a concrete platform is mentioned. We have found it advantageous and economical to build the curb, in place, at the same time that the platform is built, instead of setting a separate curb, we make the platform one thing with the curb, with expansion joints in the curb at the same points as they come in the rest of the platform. In connection with this I might say that we are using a great deal of concrete paving in stock pens, the face of the concrete being left without being finished off.

President.—If there is nothing else to be said on this subject I will declare it closed and pass on to the next.

VII.

DESIGN OF PORTABLE DERRICK AND PUSH CAR FOR SAME.

REPORT OF COMMITTEE.

To the American Railway Bridge and Building Association:

Portable derricks, especially for use on push cars, are not in general use, yet some roads have reported using them with success for many years. This report will include all manner of small cars and derricks which have come to our attention, even such cars as may be used in yards for the handling of rails, frogs, timbers, etc., for both loading and unloading of material, and which are too large for service on the road, account of being too heavy to remove from the track.

On trestle work it is ordinarily the practice to put in all timbers by hand, making use of the push car only in taking the material to the bridge, yet it must be admitted that there are times and places where a small derrick car can be used to advantage, especially where the number of men is too small to handle the timber to advantage otherwise, and particularly on branch lines where traffic is not heavy, or on industry tracks, where there is a considerable amount of bridge work with little or no traffic, excepting switching. They are also claimed by some to be very useful in picking up material from under bridges where it is not convenient to have a large derrick or pile driver, with work train, on hand for the purpose.

Letters of inquiry were sent out and extracts from replies are given herewith:

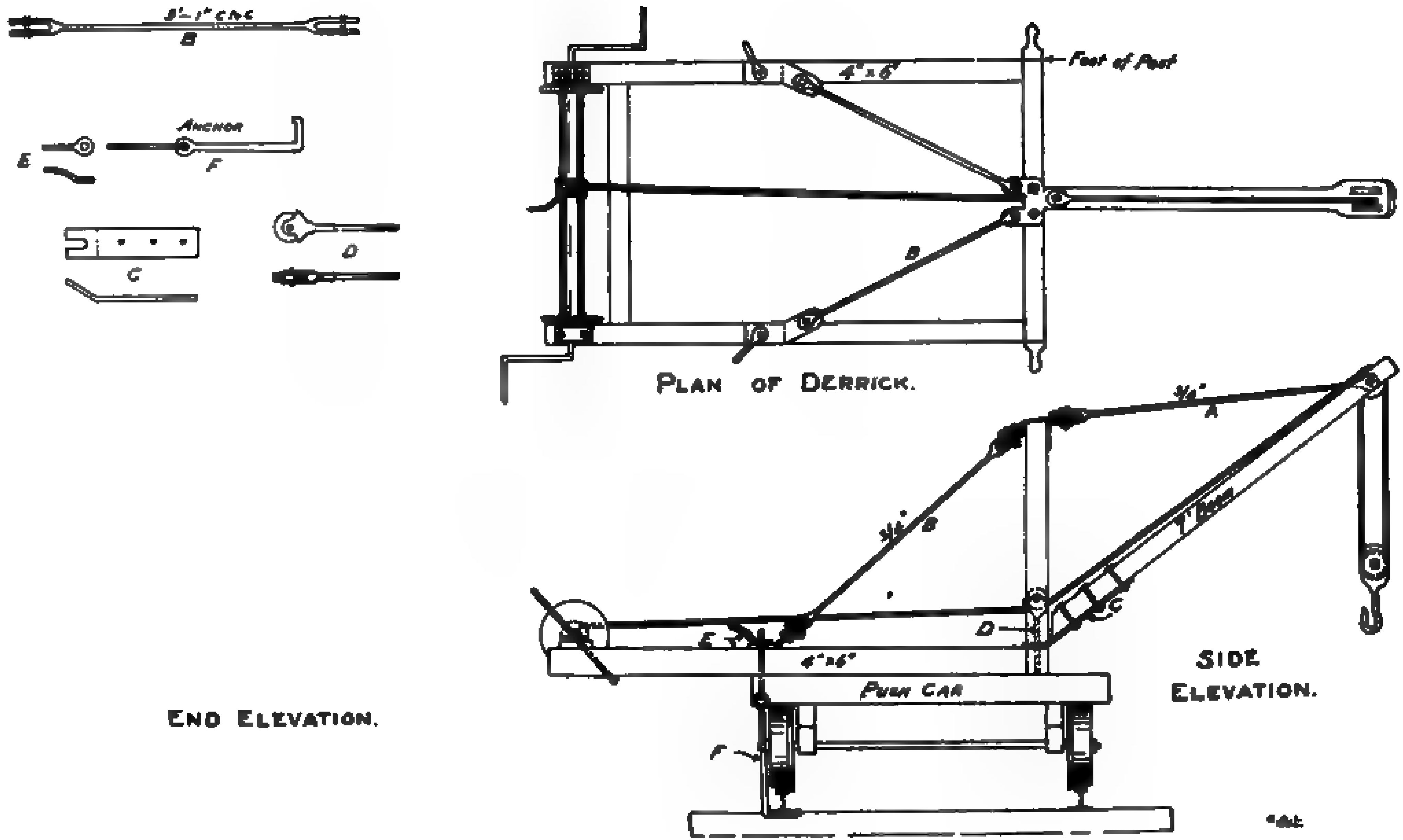
A. S. Markley, Chicago & Eastern Illinois R. R.:

I am sending you photograph showing the style of derrick we have been using on push car for the past twenty years in our bridge gangs. During that time we have never had a single accident to men or cars. This outfit with a few men is capable of handling work which would ordinarily require ten men, and will easily place or pick up and remove three 8x16-32 stringers, packed. The derrick is on a common push car and has a crab with a concave drum which feeds itself in hoisting or lowering timber. The crab is clamped to the car and a chain extends from the crab to the rail and is held thereto by the use of a hook or bar, in such a way as to make it impossible for the car to tip over. The entire outfit will not exceed twenty dollars in cost. We have used rods for guys in some cases, but find that ropes are best as they admit of a better adjustment of the derrick.

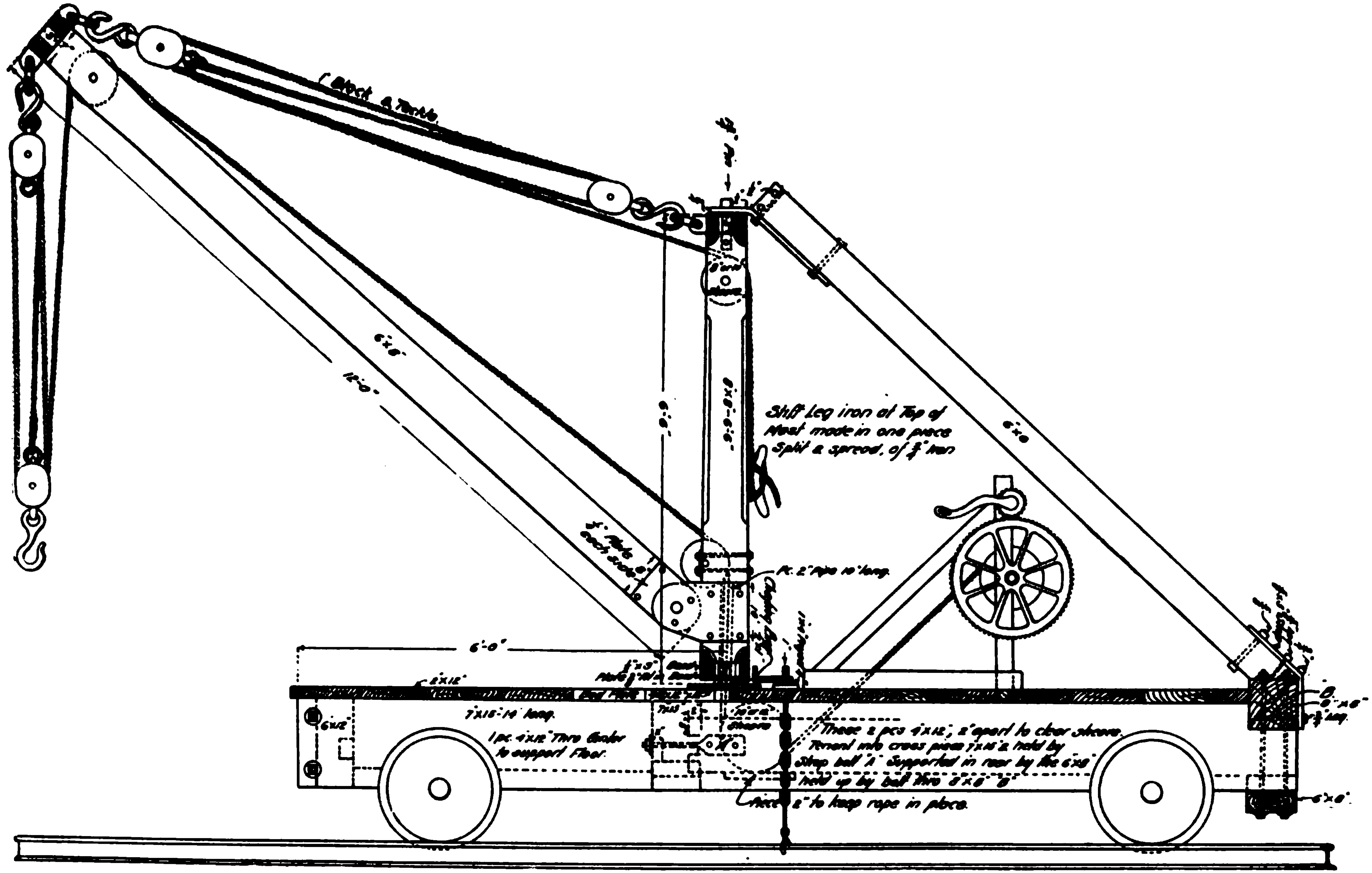
Portable Derrick and Push Car, Chicago & Eastern Illinois R. R.

Portable Derrick and Push Car, Chicago & Eastern Ill. R. R.

Portable Derrick, Louisville & Nashville R. R.



Push Car Derrick, St Louis, Iron Mountain & Southern Ry.

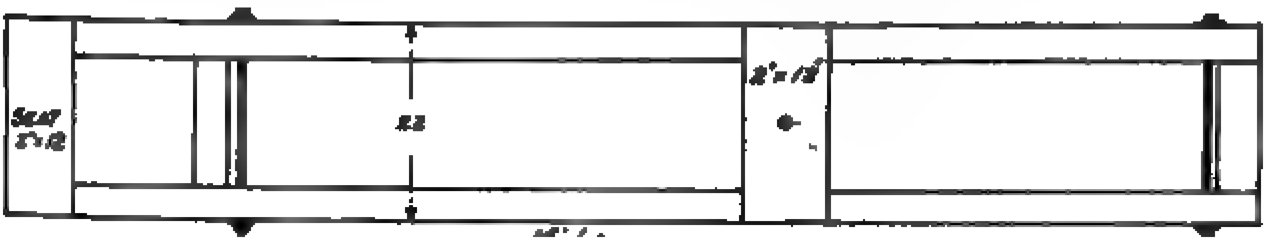


Yard Derrick for Handling Material, Missouri Pacific Ry.

Portable Derrick B & O. R. R., and St. L. I. M. & S. Ry

H. E. Walker, Southern Indiana Ry.:

We use a very simple and crude affair on a push car with which to handle bridge timbers and I find it to be a success. It consists of a simple horizontal frame, which swings on a pivot, on one end of which rests a common hand hoist. This outfit can be used to pick up quite large timbers from either side of the track. One man sits on the back end of the frame and handles the rope, while two men crank up the load. The gears may be taken from a hand car and the drum made from wood, concave in shape, as shown in the accompanying sketch. The hoist sits on the short arm of



Windlass Hoist on Push Car, Southern Indiana Ry.

the frame and can be shifted about and is used only for lifting to the height of the car, having no derrick feature in connection with it.

A. B. McVay, Louisville & Nashville R. R.:

I beg to advise that my knowledge of such appliances as portable derricks to be handled on push cars is very limited, my observation having been that such appliances for general bridge work are not very valuable; however, I now have in use on the St. Louis division a somewhat rude appliance of this kind which one of my foremen insists is very valuable and quite a labor saver.

E. P. Hawkins, St. Louis, Iron Mountain & Southern Ry.:

We have a portable derrick which is made to use on a flat car, and to be shifted from one flat to another, the power to be furnished by line from locomotive or pile driver. It is too heavy for push car

work, yet I presume a similar lighter device could be made and furnished with a hand crab and used on a push car.

We have a derrick and push car which is used in handling material in store yards, loading and unloading timber and other material around shops and storehouses, but too heavy for bridge work out on the line.

We also have a derrick designed by Mr. S. C. Tanner of the Baltimore & Ohio R. R., which is a good outfit for bridge carpenters and I think it would be well to recommend it to the Association. This is more in the nature of a hand hoist connected directly to a short boom derrick.

It is hoped by the committee that this meagre report will serve to animate a lively discussion, and that the discussion may prove to be of greater benefit to the Association than the report in itself.

J. Dupree,
A. B. McVay,
H. Rettinghouse,
E. P. Hawkins,
Committee.

VIII.

BEST METHOD OF HOUSING RAILWAY BRIDGE AND CONSTRUCTION GANGS.

REPORT OF COMMITTEE.

To the American Railway Bridge and Building Association:

The committee on subject No. 8, continued from last year, received from the former committee a vast amount of data, plans, etc., which had been collected, and it seems to us, after thorough investigation, considering the very thorough work which it did, that which is needed most at present, is not so much the further investigation and collecting of data, but more discussion and the relating of actual experience of the members of this Association.

A brief examination of the Eighteenth Annual Proceedings shows that the committee received plans and data from 41 of the leading railroads; these were very elaborate, and the committee selected those which best brought out the main features for publication in the proceedings; in view of all this the present committee did not feel that they should, in justice to all concerned, ask for additional information and data this year, but as the subject is a live one and worthy of careful study and consideration, we recommend that it receive a thorough discussion at the coming convention.

The present committee received from Mr. H. R. Higgins many plans of buildings for the housing of Panama Canal laborers, but they are more elaborate than would be required in railway service, and in fact a very few jobs would warrant such an outlay.

The subject seems to divide itself naturally under two heads: first, the housing of men engaged in ordinary maintenance work; for this, in nearly all cases, the boarding car outfit is far the better, having many points of advantage over portable buildings, especially in the ease with which they may be moved to different points as needed and the possibility of mobilizing a large force well housed, in cases of emergency, when fire, flood or wreck may have caused great damage and a large force is necessary for speedy repairs. A good sample of boarding car outfit was illustrated in the Eighteenth Proceedings. Second, the housing of men engaged in building new lines; this is where the portable or knock-down building has the advantage over the boarding car, as it may easily be carried ahead into the wilderness, and quickly erected, providing home and comfort for the pioneers, and as the work advances be moved ahead at a small cost with convenience.

We would be very glad indeed to be able to present plans of an ideal knock-down camp outfit, but have been unable to obtain one which, in our judgment, is ideal; in fact we do not consider that any

of the plans submitted for either buildings or boarding cars are strictly ideal, but we do feel that the boarding car problem has been worked out to better satisfaction than the portable or knock-down house. There is no doubt but that many railroads would find it greatly to their benefit if they provided more comfortable and convenient quarters for their construction gangs, for men well housed and well fed will do far more and far better work than if compelled to put up with poor accommodations.

B. F. Pickering.
A. F. Miller,
J. M. Staten,
A. McNab,
Committee.

President.—I will state that last year we had a very good report on this subject and it was thoroughly discussed. That being the case possibly we need not say much more on it this year.

IX.

PILE AND FRAME TRESTLE BRIDGES.

REPORT OF COMMITTEE.

To the American Railway Bridge and Building Association:

The chairman of the committee to whom was assigned the above named subject sent to the other members of the committee the following circular letter, which is printed here to show the method adopted in getting up this report:

"Please look over the list of questions which I submit herewith and make any suggestions which, in your opinion, will bring out a more complete report, or list to report upon. This is a broad subject and I may have omitted some important points. Also, what is your judgment in regard to submitting this list, when finally prepared, to all members of the Association? I believe this method has been generally adopted by committees heretofore in getting up reports; however, it entails a great deal of extra correspondence, and but few of the members seem to be willing or can find the time to respond to these requests from the various committees, as it requires a considerable amount of work, and if published in the report would be too lengthy to rehearse in full in the limited time usually accorded in the convention, and this being the case I think it would be better to confine this report to members of the committee only."

Replies from my associates approved of this method which was adopted, and the list of questions and answers follows:

LIST OF QUESTIONS.

1. What kinds of piling are used in bridges on your line, and what is your opinion of their value?
2. What, if anything, is being done in the way of preservation of timber and piling used in construction and renewals of trestle bridges on your road?
3. Give dimensions and furnish specifications pertaining to material used by your company in trestle bridges, and any opinion you have to offer concerning the utility of the material.
4. Have you a standard for ballast floor bridges on your road? If so please state your reasons for approval or disapproval of this style of structure, added cost to be taken into consideration.
5. Which parts of timber trestles are most liable to failure, or require earliest renewals?
6. Give description of system of inspection of trestle bridges on your line.
7. What precautions, if any, are taken to guard against fires other than the provisions made in decks of ballast floor bridges?

In making your replies please furnish drawings, when possible, with proper references thereto.

ANSWERS TO QUESTIONS.

W. T. Powell, Colorado & Southern Ry., Denver, Col.:

1. For several years we used only long leaf yellow pine for piling, but they lasted only about six years, so we discontinued their use, and for the past two years we have been using oak, but they are so poor, account of being so small and crooked, that we are going to resort to the use of treated short leaf yellow pine. Good oak piles will last approximately sixteen years, and long leaf yellow pine about six, unless treated, which will lengthen their service.

2. This company has never used any treated bridge timbers.

3. Our main line bridges have 13-foot panels, three-ply 8x16-26 stringers, 7x8-9 ties, 5x8-26 guard rails, and 14x14-14 caps, all of Oregon fir. Timber specifications as follows: "Each and every stick must be sawed so that all edges are perfect; must be perfectly sound and clear from sap and clear of knots that will affect the strength of the timber, and entirely free of wind shakes and other imperfections. Must be as nearly the exact dimensions as possible." Specifications for piling: "All piles must be made from straight sound live timber, free from cracks, shakes and rotten knots, and must show an even taper from end to end; must be sawed square and bark removed. The pile must be not less than fourteen inches at the butt, and not less than ten inches at small end."

4. We do not use any ballast floor bridges.

5. Our main trouble is with the piling. The long leaf yellow pine rots out in about six years, while the decks of Oregon fir will last fifteen years. We sometimes have to change the ties sooner on acount of being cut into by the rails.

6. We make a general inspection once each year commencing about September first. We dig around the piles to see how much they have rotted; also look for broken stringers and caps, as well as all of the other members. Some of the bridges are inspected several times each year; that is, our foreman, general foreman and myself look over carefully any bridges we may be near.

7. We have no fire protection for bridges except for a few which are provided with water barrels.

J. F. Parker, Santa Fe Coast Lines, San Bernardino, Cal.:

1. We use mainly Oregon pine for piles. Have used some white cedar, also long leaf and short leaf yellow pine. The white cedar has given the best service, lasting from eight to fifteen years, depending upon soil and other conditions. Second cuts do not last so long. Oregon pine has given nearly the same length of service under like conditions. Oregon pine, however, in recent years, both for timber and piling, has been very inferior in quality as compared with that of ten or fifteen years ago. My experience with Texas pine dates back only about three years, consequently I am unable to give any information as to its probable value.

2. Creosoted timber and piling are being mainly used for construction, renewals and repairs of trestle bridges except for stringers and ties.

3. Caps, 12x14-14.
   Stringers, 4 ply 7x16-28.
   Ties, 6x8-14.

Guard rails, 6x8-14.
Sway braces, 3x10.
Cap struts, 6x10.
Longitudinal girts, 6x10.

4. We have a standard for ballast deck bridges, cuts of which appear on pages 165, 166 and 167 of the proceedings of the sixteenth annual convention. It consists of six piles per bent, 14-foot centers; 14x14-16 caps; solid close laid floor of creosoted timber 8x14 under the ties, and 10x10 from the ends of the ties each side to make up the full width of the bridge. I approve of this style of construction and consider it a good bridge in every particular. Thoroughly screened hard rock ballast should be used, for if fine gravel and stone dust collects at the bottom of the ballast it will hold the moisture and in time will rot the timber.

5. In our soil, piles are first to fail and require earliest renewals, except in salt or alkali ground where they will last twenty years or more.

6. We make one general inspection annually, in May or June, when the condition of all parts of trestles is carefully noted, and records made thereof. When the notes are written up copies are sent to the general superintendent and chief engineer. We also have a regular bridge inspector who is constantly going over the line, looking after the welfare of bridges, drain boxes, buildings, mail cranes, etc.

7. Our largest trestles are now provided with metal water barrels which are kept filled by freight engines. The ground under and about trestles is kept free from dry weeds, grasses and other combustible material.

L. D. Smith, Southern Pacific Co., San Francisco, Cal.:

1. For piling we use Oregon pine and Washington fir, creosoted, except for temporary work. We believe this is the best material for the purpose on the coast.

2. All piles are creosoted at the company's plant, using ten pounds of creosote per cubic foot. We do not creosote any other material in trestle bridges.

3. We use 12x14 caps, 8x17 stringers and 6x8 ties. (Pacific Coast Specifications, Harriman Lines.)

4. We use ballast floor trestle bridges wherever we have sufficient head room. The cost is about twenty per cent greater than for open deck, but they are easier to keep in line and surface, and the stringers will last almost twice as long as in open trestle. The decks are fireproof; trains pass over them with less noise and jar, and the ties at the ends of the bridges on the embankments do not pound down as at the ends of open deck bridges. Such bridges require little or no repairs for fifteen to twenty years.

5. In open trestles we find that the tie gives out first under the tie plates, by crushing and rotting, where plates are used. In untreated trestles the piles give out first, thus requiring the renewal of the entire structure, or a very heavy expense for the redriving of piles. It seldom pays to drive a pile bridge and maintain the old deck.

6. Trestles are inspected quarterly by the superintendent of bridges and buildings, or his representative, and annually by the general bridge inspector. The piles are examined to a depth of

eighteen inches below ground line. A common method is to sound the pile with a hammer, and those which seem to be decaying inside are bored. The same rigid examination is also made of the decks, and an estimate prepared of all that is required to keep the trestle in good repair for a year.

7. The only provision we have made so far on open decks, is to paint the ties and tops of stringers and caps with fireproof paint. Water barrels are also provided and kept filled with water.

I am indebted to Mr. G. W. Rear, general bridge inspector, for the subject matter of these answers, for, since leaving the Gulf, Colorado & Santa Fe Railway I have not had anything to do with bridge work.

B. J. Mustain, El Paso & Northeastern R. R., El Paso, Texas:

1. We use Texas pine in all of our pile bridge work. All piles are creosoted, which seems to be the most satisfactory treatment for use in this hot and dry climate.

2. All bridge timbers are creosoted, and built of 3x12 solid flooring on top of ten 8x16 stringers, as shown on pages 192 and 193 of sixteenth annual proceedings, which makes the bridge a very substantial structure. Caps 14x14-14. We use regulation size track ties with eight inches of gravel ballast between the planking and the ties. This makes the bridge fireproof from above, as any one tie will burn without destroying the bridge. This style of bridge is the best I have seen, and while more expensive to repair, it is more than offset by the greater length of life of the timber.

3. Where frame bents are used they are built on concrete foundations. Five 12x12 posts are used on sills of the same size. Sway braces, 3x10, are bolted to the sills, posts and caps. On double or triple deck bents, 8x12 line girts are used, and on heavy grades a diagonal brace reaches from the cap of one bent to the sill of next bent, which takes the place of tower bracing. I think, however, there is no method of bracing that is quite so safe as tower bracing. The El Paso and Southwestern is the only road where I have seen this style of diagonal bracing in use.

4. These bridges are all ballast decked.

5. Piling and posts at the ground line are first to decay, and consequently the first to receive attention.

6. Inspection is made twice per year, by digging around piles and sills, and testing them with bar or auger; estimate is then made of the amount of material that will be necessary for repairs or renewals. We make the inspection on a light train.

7. Where bridges are not ballasted, a 2x6 is placed between the ties and then covered over with gravel, which makes a good fire protection.

A. H. King, Oregon Short Line R. R.:

1. Oregon fir is universally used throughout this section for bridge work, either untreated, creosoted or salt treated. The latter method consists of placing the timbers in the waters of the Great Salt Lake, and should be kept submerged a year or longer. As long as the saline coating remains on the timber the crust proves a very valuable preservative, and piles driven 25 to 30 years ago in the lake are in perfect condition, but we are yet unable to say what

the results may be when thus treated and used in other places, remote from the lake. Creosoting will prolong the life of piling, but the practice is so recent with us that we are unable to say how much longer.

2. Answered in No. 1.

3. Our common standard pile bridge consists of five piles in each bent. Three stringers 8x17-30 centered under each rail: 6x8-9 fir ties: 5x8 guard rail and 12x14-12 fir caps. Piling is driven on a batter in such a way that if center lines of the piles were extended they would meet 28 feet above the rail. Our company is of late favoring the ballast floor bridge for main lines. For this type we use a 16-foot cap and 12 stringers and four-inch floor covered with prepared roofing over which is spread a coat of asphaltum about one-half inch in thickness (see plan). The prepared roofing and asphalt are used with the intention of making a watertight floor to keep the moisture from getting to the stringers. We have had instances where this style of covering for some reason was not a success; however, we believe this was due to the result of careless workmanship. A bridge stringer is bolted to the outside to retain the broken stone or gravel ballast, and common track ties are used. With treated piling and this style of deck we expect to add to the life of the structure, get better fire protection, and show less cost for maintenance, as the matter of line and surface is taken care of by the section men. We estimate that the various members of this style of structure will last about the same length of time, and that the added life of the structure will amply repay for the additional expense incurred in its construction.

4. Answered in No. 3.

5. In this inter-mountain country, where rains are infrequent, the deck of a bridge lasts longer than the piles. Piles which do not reach the water are the first to fail, but by treating them, and driving five or six to the bent, instead of four, as was formerly the custom, we expect to remedy this to a considerable extent. Experience has taught us that white oak piles will last longer than fir under average conditions, when not treated. By using treated piling we expect to prolong the life of them so that they will last as long as the superstructure.

6. Usually we start our bridge inspection about the first of September by making use of an engine, superintendent's car and caboose, the party being composed of the division superintendent, division engineer, supervisor of bridges and buildings and the roadmaster. For us, this system is the most satisfactory, and we get the best results. We make a very thorough and rigid inspection in every particular, examining faulty piles and timbers with a five-eighths steel bar. It is intended that the material in a bridge shall remain as long as it is safe, but the inspections are made in such a way that necessary repairs shall not be overlooked.

7. On open floor bridges, on branch lines, we plank between the ties, and block the openings at the ends of the ties, under the guard rails, and fill in with ballast, and we find a notable decrease in the number of fires in trestles. Bruised or partially rotted ties, bulkheads and caps where sparks are liable to find a lodging place are an element of danger, and a double reason presents itself for the removal of such. Water barrels on high timber trestles should be watched closely, and kept full of water. The ground beneath

For trestles more than one story in height longitudinal girts
cap,
cap
sway
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THE CENTER LINE OF PILES PROLONGED SHOULD MEET AT A POINT ABOUT 26FT ABOVE BASE OF RAIL.

Single Track Ballasted Deck Trestle Oregon Short Line R. R.

trestles should be kept free from weeds, grasses and other combustible material, which I think is a general rule on most roads.

The subject of Pile and Frame Trestle Bridges has received consideration in a number of our former proceedings.

A. H. King,
J. F. Parker,
W. T. Powell,
B. J. Mustain,
L. D. Smith,
Committee.

DISCUSSION.

Mr. King.—In this report I have mentioned the salt treatment of timbers. This is not of interest to the Association as the treatment consists merely of placing the timbers in the water of the Great Salt Lake. I believe that all other features of the report have been discussed when we had the same subject up at previous meetings.

Mr. A. S. Markley.—In this report Mr. King shows the use of prepared roofing and asphaltum on a ballasted floor bridge. Does that not hold the water above the flooring and make a bad job of it? It looks as though it would certainly hold the water if rain fell on the track.

Mr. King.—Our chief engineer recently asked if it were not a fact that water was getting through this protection to the floor, and we found that it was in some places, but we believe, that by putting it on heavier we can keep the water from getting through. That is our plan, to keep the moisture away from the structure altogether. We think it is a very good bridge, inasmuch as it is protected against fire, and by reason of the extra amount of timber there is very little danger of broken stringers. It is a little more expensive, but we think it has justified the expense. It will also show less cost for maintenance as the matter of line and surface is taken care of by the section men.

Mr. A. S. Markley.—Do you not believe that if you had something to carry off the water instead of holding it there, it would be better?

Mr. King.—There is an outer guard rail which holds the

ballast on, and a washer one inch thick is placed between the guard rail and the floor, so that the water is permitted to flow off through that opening. The floor is made level, but if done again I think we would put down to a curved surface.

Mr. A. S. Markley.—Do you have any trouble with the ballast cutting through the water proof substance?

Mr. King.—We do not use broken stone for ballast at all on our line, but fine gravel. Broken stone would be objectionable, because it would cut into the asphaltum.

Mr. Clark.—How long have you had this kind of bridge in use?

Mr. King.—We have been building these for about five years. This is not long enough to be an absolute test as to whether the stringers will last without deterioration to such an extent as will necessitate the renewing of the entire deck. I would consider, however, that by keeping them entirely dry the life of the stringers would be prolonged. In our territory the piling goes first, and, almost invariably, when it is necessary to renew piling we find the superstructure good and very frequently use the stringers again. It is very uncommon for the stringers to decay, or any other part of the superstructure, except the ties. As far as rot is concerned, we have but little trouble from that, and our idea has been, since the inauguration of this plan of bridge, that it would result in every part wearing out at about the same time. We creosote our piles, and if the piling will last I think the superstructure will be good for another twenty-five years.

Mr. Clark.—I know of a bridge constructed on similar lines. The builders used second-hand stringers and they find now, after about five or six years, that it will only be a year or two until they will have to tear it down and rebuild it.

Mr. Sheldon.—In regard to the durability of that plan of construction: Some 18 years ago we had a few spans where we wanted to make a continuous roadbed. We put on second-hand I-beams and covered these with four-inch

plank, and laid on this a tarred felt and pitch roof, and dumped gravel on it. Occasionally we look under this bridge and we find it still in good condition. I know of nothing better than a tar and felt roof. This structure will probably last twenty-five years before there is any decay to the timber.

Mr. Reid.—The question has come up several times as to the advisability of building ballast-deck trestles. I do not think that it pays to build a ballast deck unless one can use creosoted timbers. If one is to put a ballast deck on that will be proof against water, unless the timbers are creosoted I do not think it will last as long as a deck without the ballast. There is also a question as to whether it pays to use creosoted timber in trestles at all, as the changes in locomotives and equipment usually require changes in the structure before they wear out, even if not creosoted. Our ordinary timber trestles will last about 14 years, and that is about as long as any trestle will last under our traffic, by reason of changes in the rolling stock.

Mr. A. S. Markley.—It is hardly conceivable that there will be any heavier equipment than we have now.

Mr. Reid.—It is not simply a question of heavier locomotives, but other changes come up. As a road grows older and can stand the expense there are changes in alignment, changes from temporary to permanent structures, or other changes which make it expedient to take out these temporary structures.

Mr. Clark.—Answering Mr. Markley. I do not see any signs that we have reached the limit in weight of locomotives or other rolling stock. It would not surprise me to see about as much change in our rolling stock in the next ten years as there has been in the past ten years. To my knowledge a certain company is experimenting with a car that will carry 200,000 lbs. If it is found to be a success they expect to put such cars on the road, and if they do it other companies will do the same.

Mr. Hudson.—I would like to ask the experience of the

members in applying caps. My observation is that the caps give way before the piling. Our standard is 14x14 for a ballast deck and six-pile bents. Figuring on this it is one-third cheaper than a permanent structure.

Mr. Reid.—Can any one say what these ballast-deck trestles cost per foot, designed for a load equivalent to the Cooper E-50 locomotive? Most roads now would have to design trestles for a load 20 per cent heavier than a train of 20-ton steel hopper cars. There is no question in my mind but what we will get this very soon. If the cost is much more expensive than ordinary trestles it is a question whether it would pay to build them.

Mr. King.—The cost per span, where not carried to an excessive height, say sixteen feet, is perhaps in the neighborhood of $250 or $300 per span, or an increase over the ordinary trestle of perhaps 50 per cent. However, I wish to say that this plan of construction is not provided for any of our branch lines; only for the main lines and where the traffic is heaviest. We have a standard for the branch lines which we consider good enough for the traffic. Moreover, we expect to allow structures of this kind to remain in place until they fail. We will not change them out simply because they are wooden structures. If these bridges prove to be good for, say, another 20 years to come the probabilities are that they will be allowed to remain until they fail, and at that time I presume the question of replacing them with permanent structures may be taken up.

X.

DOCKS AND WHARVES.

REPORT OF COMMITTEE.

To the American Railway Bridge & Building Association:

The Committee on Subject No. 10—Docks and Wharves, including Appliances for Transferring Cars from Wharves to Floating Equipment and Best Method of Transferring Freight from Dock Warehouses to Vessels, and from Vessels to Dock Warehouses at Various Stages of Water, respectfully submits the following report:

The subject of Docks and Wharves was reported on and discussed at the 1905 Convention; for that reason this part of subject No. 10 will be touched upon only in a general way by this Committee.

That part of the subject relating more particularly to transferring passengers from terminal stations, and freight in packages or carload lots from wharves to vessels or vice versa, will be treated more in detail.

In order to obtain the information in regard to the practice of handling passengers and freight at various points, the Committee prepared circular letters containing a number of questions relating to this subject, and mailed them to the members of this Association. The Committee, however, was not very successful in obtaining data; out of 43 inquiries sent out, only seven replies were received, and of these only four contained information on the subject matter.

The report of the Committee will necessarily have to be based principally upon research from engineering publications and reports of other associations.

DOCKS AND WHARVES.

These are general terms for structures located at water terminals where vessels are docked and where freight is transferred from vessels to freight sheds, railroad cars, etc., or vice versa.

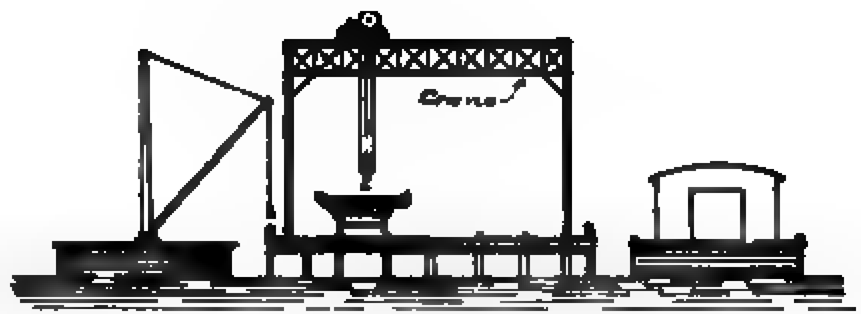
The various structures comprising the docks and wharves at a terminal may be classified as follows:

Lighterage Piers:

Open deck or covered piers at which freight is loaded directly from cars to vessels, or vice versa.

Export Piers:

Covered piers with one or more floors, to which freight is unloaded and stored for shipment by steamers or coast vessels.



Section

Scale

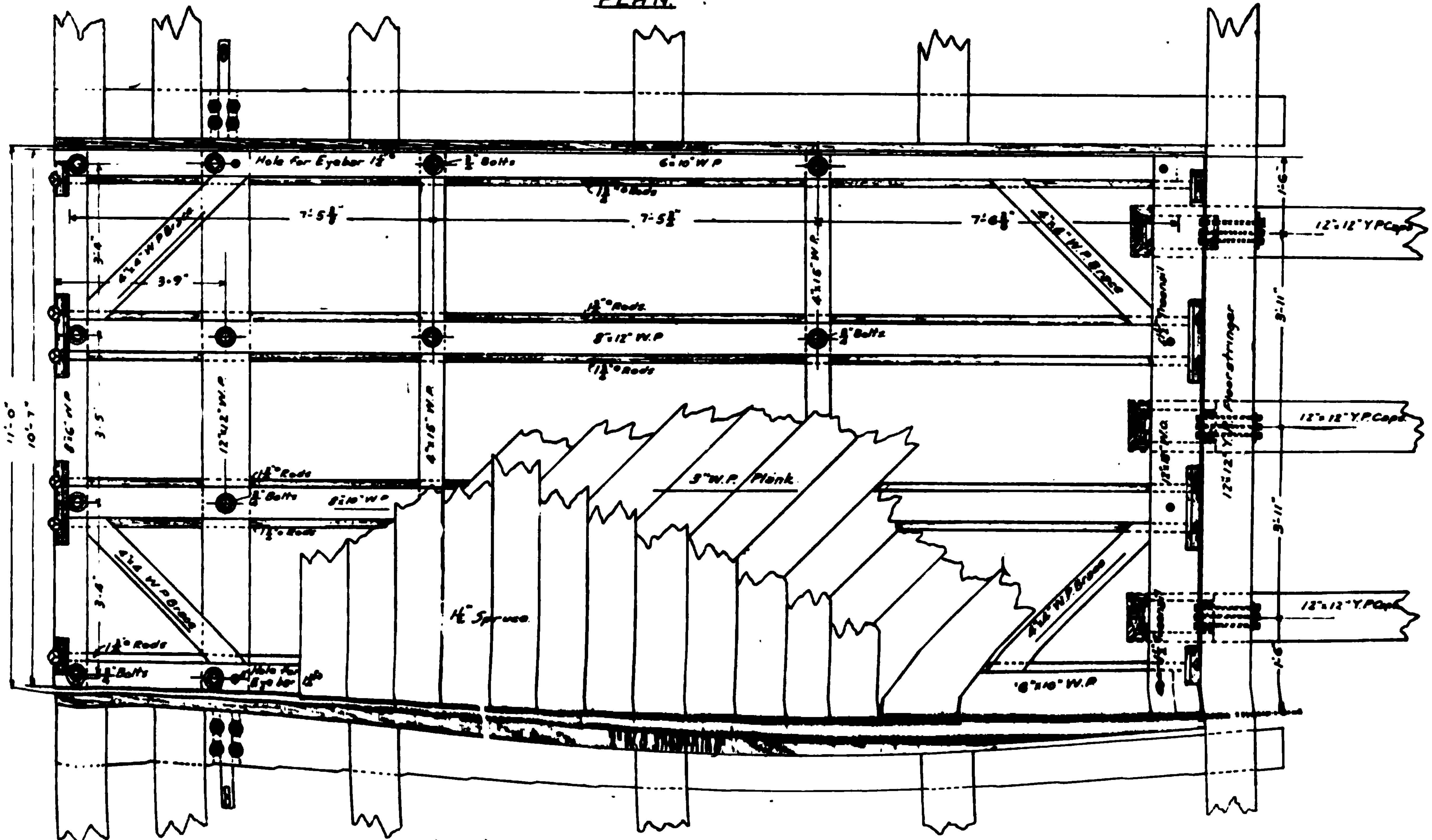
Open Lighterage Pier

GENERAL FRONT ELEVATION.

Scale

Plan of Gangway Bridge. Freight Piers L. V. R. R., at Jersey City. (See next page.)

PLAN.



Plan of Gangway Bridge. Freight Piers L. V. R. R., at Jersey City. (See preceding page.)

Landing Piers:

Open decks where cars are shipped and received by means of car floats, transfer steamers, etc.

Station Piers:

Covered piers without rail connections where freight is shipped and received by car floats, house barges, etc.

Coal Piers:

Open piers where coal is transferred from cars into barges or steamers either by gravity or special lifting or conveying machinery.

Ore Piers:

Open piers where ore is transferred from cars into vessels or vice versa.

The size of the various piers above named depends entirely on the amount and kind of business done at such piers.

For general information, the following may be of interest:

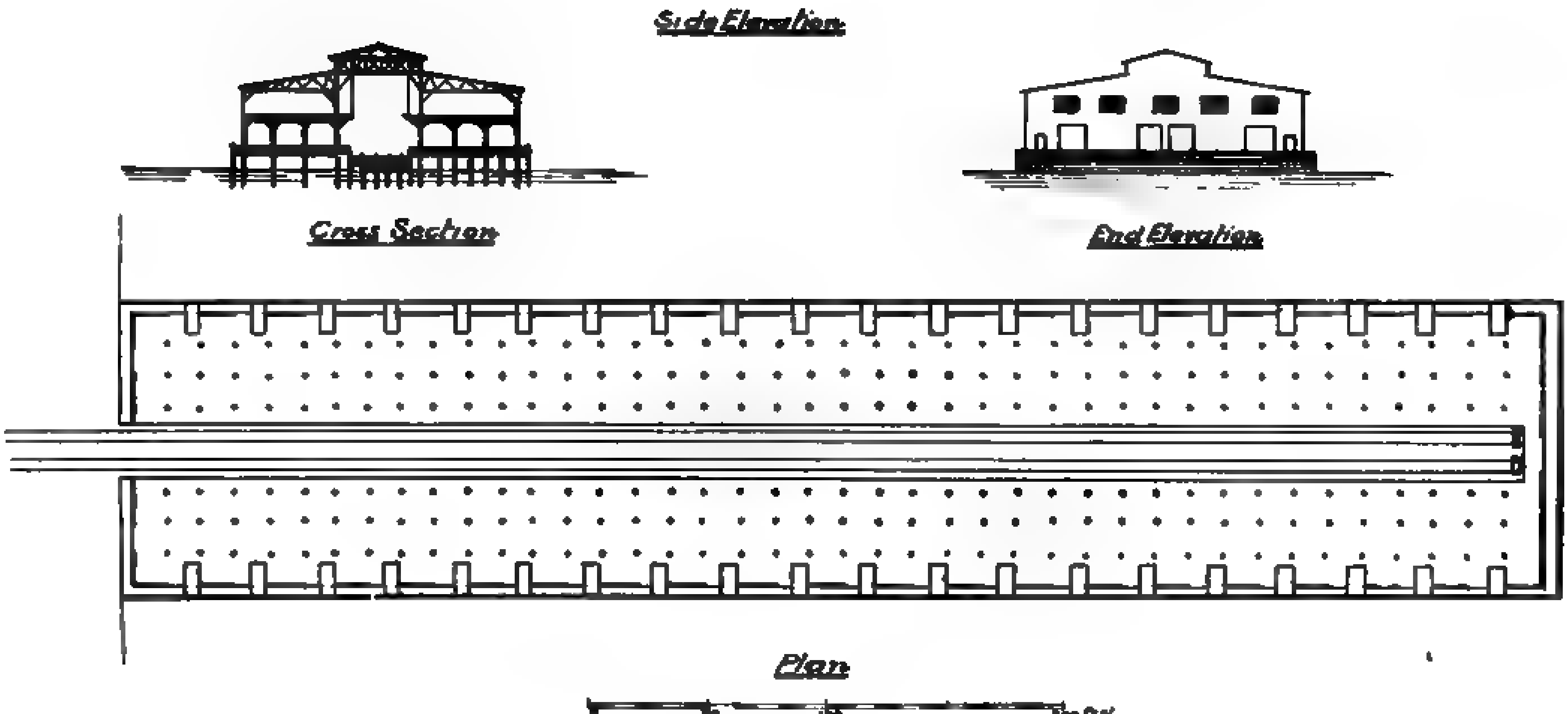
Open Deck Lighterage Piers need generally not be over 35 to 40 feet wide with two tracks along center of pier. The tracks may be depressed so as to bring the floor of cars on a level with the floor of pier on each side of the tracks. The length should preferably be from 400 to 600 feet, to give ample frontage for boats to lie alongside of pier, for discharging or loading.

Covered Lighterage Piers should generally be 110 to 125 feet wide and about 600 feet long, with two tracks in the center, the level of the tracks to be depressed so as to bring the floor of the cars on a level with the floor of the pier. There should be a platform on the outside of pier shed not less than 4 feet wide, provided with mooring piles and posts for tying vessels. The posts of the shed should be so spaced as to suit the spacing of gangways of lighters as much as possible, and the doors be arranged in such a manner as to facilitate the handling of freight. At wharves where the range of tide is not large, the sides of the piers are generally equipped with short gangway bridges that can be raised and lowered to suit small differences in the rise and fall of the water, to facilitate wheeling and transferring freight to harbor barges, etc.

The pier shed superstructure should generally be of steel construction or slow burning mill construction. If wood is used, it should be painted with fireproof paint or whitewashed to prevent sparks from setting fire to it. The outside of shed is often covered with galvanized sheet iron. The roof should be designed flat with a monitor along center of house provided with windows, to furnish as much light as possible. The shed should be lighted with electricity at night, and be thoroughly equipped with hydrants, fire plugs, automatic sprinklers and buckets, for fire protection.

Export and Storage Piers:

These should be about 125 feet wide and from 600 to 800 feet long, depending upon the class of vessels calling at the pier; they should be built for ample storage capacity. Generally two-story



Storage Pier

sheds are used for these piers on account of the height of ocean steamers, the first story about 20 ft., the second story about 18 ft., clear height, making height from top of pier to eaves about 42 ft. A platform about 6 ft. wide should be provided on the sides and water ends of piers; on this platform to be placed mooring piles and posts for fastening vessels, etc. These piers should be provided with two tracks running along center of pier shed, the tracks to be depressed to bring floor of cars on a level with the floor of the pier. In some cases it is desirable to run an open track along one side of shed for unloading direct from cars to vessels, in which case the platform on the track side is to be made not less than 12 ft. wide. The pier shed should be provided with monitors and windows in the roof, and also a number of smaller windows along the upper part of sides of second story. The shed should be lighted by electricity and be provided with fire hydrants, chemical fire extinguishers, automatic sprinklers, chemical engine, buckets, etc., to give full protection against fire.

For handling freight between the two stories, when a track cannot be provided on the upper floor, a suitable number of elevators for freight and endless barrel elevators should be provided. Spiral or inclined chutes may be provided for lowering certain kinds of freight from the upper to the lower floors of pier sheds.

At piers where passengers are landed from steamers, etc., the upper floors are frequently used in part for such purposes.

Landing Piers:

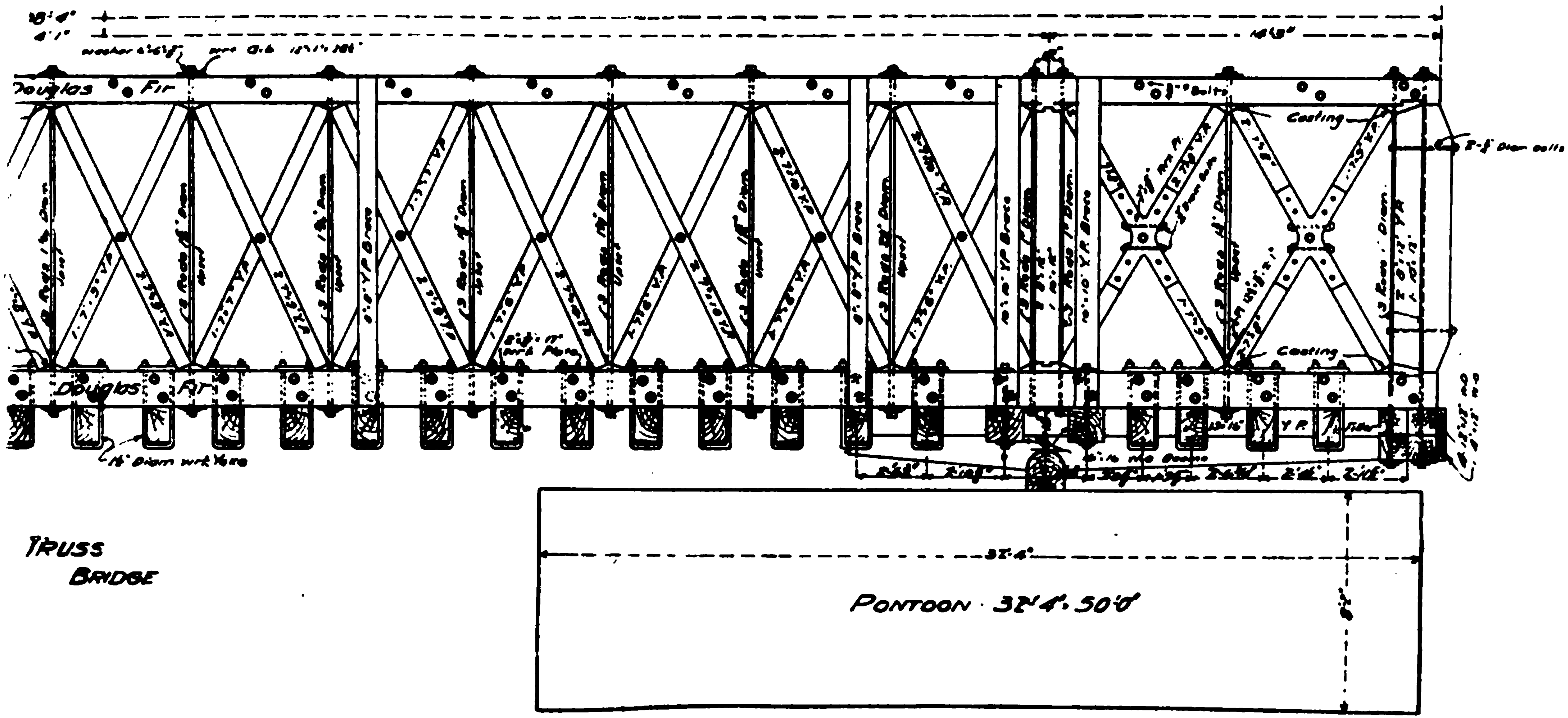
These piers have rail connection with the yard tracks and generally form the bulkhead and support for transfer bridges upon which cars are transferred from the land to the floating equipment, or vice versa.

Station Piers:

These piers or freight stations are generally located along the harbor where no rail connections can be made and freight is delivered by car floats or transfer steamers and passengers by ferry boats. The size of such piers again depends largely upon the amount of business handled, and in some cases, like New York Harbor, more frequently upon the amount of room available. For freight service such station piers should be, where the room is available, from 110 to 125 feet wide, and about 600 feet long, providing for a driveway along the center and storage along the sides. A 3 ft. platform should be provided on the three sides of shed along the water, equipped with a proper number of mooring cleats, piles or posts, for tying car floats and other vessels. Incoming freight will be delivered to pier by car floats, and cars unloaded there, while the outgoing freight will be received, preferably from a bulkhead along street adjoining the water edge, where the heads of car floats can be tied to bulkhead and the freight delivered over the end of car floats on the center platforms direct to the cars on the floats; in this manner the handling of outgoing freight will not interfere with the handling and hauling of incoming freight.

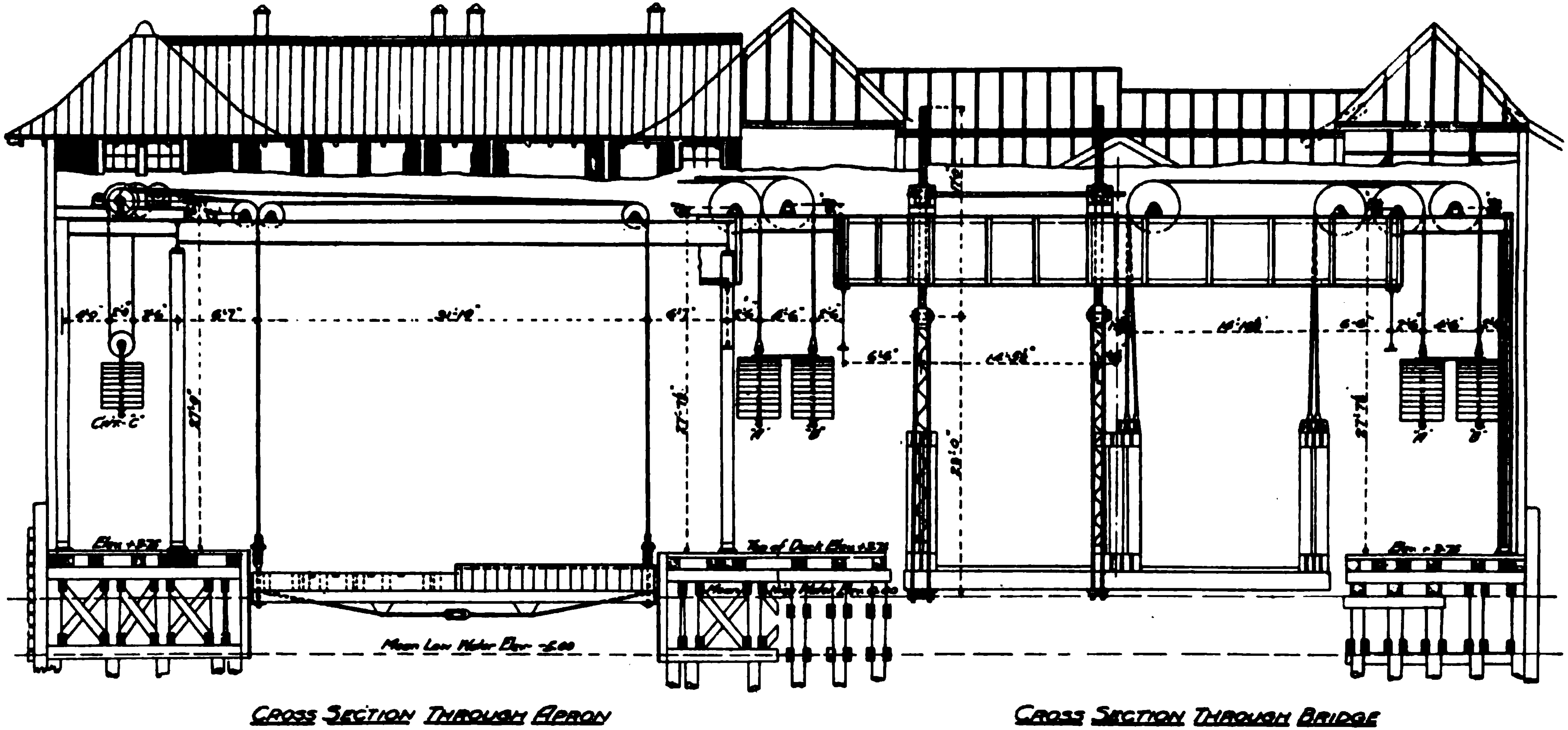
For the passenger service special landing slips and bridges are provided. The ferry boats enter the slip, the hinged bridge is

Plan No. 1. (Other half shown on opposite page.)



Plan No. 1. (Other half shown on opposite page.)

Plan No. 2.



GENERAL PLAN OF TRANSFER BRIDGE
WITH OUTER END SUSPENDED FROM OVERHEAD TRUSS

Plan No. 2.

raised or lowered to suit the height of lower floor of ferry boats, and, after the boat has been properly secured by means of hand winches on the bridge, the passengers pass out. A small difference in height between the floor of ferry boat and the hinged bridge is generally overcome by placing small movable platforms from boat to bridge to allow foot passengers to pass without danger or difficulty. In double deck ferry boats, overhead hinged bridges are provided for landing passengers to second story of passenger shed or station.

Coal Piers:

These are generally built of such height as to admit the dumping of coal from hopper-bottom cars into pockets provided in the pier and let through chutes directly into the vessels. The chutes are arranged so that they can be raised, lowered or extended, to suit the requirements of the vessels loading coal. At coal piers usually special arrangements must be made in the chutes and pockets to reduce the drop of the coal on account of breakage. Screens are also required for hard coal chutes to clean the coal from dust. Coal piers are built with three or five tracks on the top deck. When three tracks are used the two outside tracks are used for loaded cars and the middle tracks for the empty cars. The grades and switches are generally so arranged that the cars, when unloaded, can readily be moved to end of pier, and from there over to the center track, the grade of which descends in an opposite direction from the loaded car tracks, to drop the cars back toward the shore and general yard.

For long piers generally five tracks are used. The two tracks nearest to the edge of the pier are used for loaded cars, and coal is dumped from both tracks and delivered by chutes to vessels, while the center track is used for return track of empty cars similar to the arrangement of 3-track pier.

The pockets on the pier and the chutes should be so located as to suit the lengths of cars, and the crossover switches between the loaded car tracks should be so arranged that cars can readily be shifted from one track to another when desired, to bring the needed grade of coal to a certain vessel; this is especially necessary for piers where hard coal is handled, on account of the many grades of coal provided for the market.

Locations of coal piers.—Where a down grade can be obtained from the general yard to the top deck of the pier, and the top deck also have a downward grade with the traffic, it will give the best results, as coal can be quickly delivered to the pier; where this is not possible, the arrangement of grades in the yard on approach to pier should be such that the cars can readily be delivered near the end of the pier. At this point a steep incline is provided and cars are pulled to top of pier by means of steel cable and stationary engines, or the cars may be run out on lower deck to near sea end of pier and hoisted on an incline to top, and then let the loaded cars drop back over pockets for unloading and returning to empty car yard. The delivery of coal for such piers is necessarily slower than for locomotive delivery where a number of cars can be delivered over the various tracks leading to pier. Another plan may be used by providing an upgrade to water end of pier, pushing the cars

from the yard to outer end, and letting them drop back, on down-grade, over the pockets for unloading and returning to empty car yard, the switches being so located that the cars can be led to one or more tracks where light car trains are made up. The grades are generally such that cars are allowed to move, without requiring an attendant, to empty car yard.

Another system of coal pier in use is the so-called car dumps, where loaded cars are raised upon a steel frame by hoisting machinery by stationary engines, and dumped by the frame holding the car tilting and spilling the coal into a large chute over which the coal is delivered into vessels. The capacity of such plants is also limited on account of taking care of only one car at a time, and, in case of a breakdown in the machinery, the plant is idle, while for locomotive delivery piers interruptions on account of breakdowns are not as frequent, nor do they cause the stoppage of the plant, as cars can be delivered on several tracks and by the turnouts and crossovers to numerous pockets on the piers.

Coal piers, where arrangements can be made for storing a quantity of coal in the pockets of piers preparatory to loading vessels, will be of advantage.

All coal, before entering the shipping pier, is generally weighed, and a suitable track scale will have to be provided a proper distance from the entrance to pier.

Ore Piers:

Piers for loading ore into vessels are built and used much on the same general principle as coal piers. When favorable, the cars should be delivered on top of the pier by locomotives. The piers should be made of such width and height as will take care of the kind and size of vessels to be loaded.

Ore piers for loading ore from vessels into cars or on stocking piles on piers are arranged quite differently from the piers for loading ore into vessels. Open deck piers are used for loading ore into cars, the vessels are tied against the pier, and the ore picked up in the boat by a grab bucket; these buckets being operated in a number of ways. The simplest and crudest method is by hoisting the bucket from the hold by a derrick and hoisting engine on the vessel, and then by the so-called telpherage method moved to the pier with a rope operated by a hoisting engine on the pier. Numerous hoisting engines and derrick poles are provided along the dock to admit working from the various hatches in the vessel. Another more modern method is to provide on the pier an electrically operated hoist or hoists mounted on a steel frame with long arms reaching from the pier to the center of the vessel. These hoists are movable on a track parallel to the pier, the buckets are lowered into the vessel from the long arms, and, when loaded, are raised to the proper height to clear cars, and then moved on the arm by means of a small trolley toward the car, and the ore dropped into the cars standing on a track between the edge of the pier and the side of the hoist. For storing ore on piers or ground back of piers generally long armed traveling hoists are used, reaching from the boat beyond the pier, the ore is picked up by grab buckets, raised to proper height, and then moved along the arm of the hoist to point of storage. These hoists are also mounted on tracks and can be moved parallel with the pier.

The long arm hoists can also be used for loading ore from the vessel direct into cars or from the storage dump into cars standing adjacent to and parallel with the pier.

The foregoing description of the various piers will give a general idea on the subject of docks and wharves, and, while in some instances the subject of handling freight, etc., had to be touched upon to give a clear description of a certain pier, this subject will be treated in detail in the following paragraphs.

Appliances for Transferring Passengers and Freight from Wharves to Floating Equipment:

a. Transferring passengers in cars to floating equipment and vice versa.

b. Transferring passengers from wharf stations to floating equipment and vice versa.

c. Transferring freight in cars to floating equipment.

d. Transferring package freight from pier freight sheds and warehouses to floating equipment or vessels.

e. Transferring package freight from floating equipment or vessels to piers, freight sheds and warehouses.

Passengers in cars are transferred over transfer bridges to a car float or transfer steamer, moored to the transfer bridge.

The transfer bridge is either a wooden or steel girder or truss bridge, hinged at the shore end or bulkhead so as to allow a vertical movement of the bridge. The outer end of the bridge is generally supported on a pontoon which rises and falls with the tide or variation in level of water. The pontoons are generally provided with a pump to facilitate raising and lowering of bridge. The modern transfer bridges, especially where passenger equipment is handled, are hinged at the shore or bulkhead end similar to the above mentioned pontoon bridge, but the outer end is supported by steel bars and heavy screws from an overhead steel frame and girders. These modern transfer bridges are usually built with an apron or second span to allow a larger vertical movement, and to produce easier grades for the motive power to be moved over it. The shore end of the transfer bridges being fixed on a pin bearing, even for moderate differences between high and low tides or water, junctions of grades are produced that must be regulated to the maximum vertical movement provided for in the cars, so as not to lift them from their bearings or otherwise injure them. The general styles of the single span transfer bridges usually employed for handling freight traffic are shown by Plan No. 1, and those of two spans generally used for passenger cars are shown by Plan No. 2 attached.

The Intercolonial Railway Co. have in service at Mulgrave, Nova Scotia, and Point Tupper at Cape Breton, a three-leaf or three-span transfer bridge to serve steel transfer steamers carrying both freight and passenger traffic across the Straits of Canso. The shore span is a through truss 100 ft. long, the middle span girders 50 ft. long, and the outer or sea end span girders 35 feet between supports; the latter is provided with a 15 ft. overhang over supports to allow the transfer steamer to reach under the bridge while being loaded.

A very complete description and photographic views of the transfer bridges of the Intercolonial Railway at Mulgrave, Nova Scotia,

and Point Tupper at Cape Breton, and the transfer steamer Scotia, has been furnished by Mr. John Forbes, Bridge Engineer of the Intercolonial Railway, and is given in full in the Appendix.

The floating equipment for transferring passengers in cars generally consists of steel ferry or transfer steamers on the deck of which are laid two or three tracks, as the traffic may require; these tracks usually converge to two tracks at the ends, to fit the tracks on the transfer bridge. The transfer steamer is brought up against the end of the transfer bridge, and by means of toggle bars a connection is made between transfer bridge and transfer float or steamer, bringing the level of rails on one plane. To hold the transfer float or steamer in position against side motion, guard racks or fenders are provided forming a berth for the transfer vessel; to this rack or fender, as well as to the transfer bridge, the float or steamer is securely fastened or moored before any loading or unloading is done. The work of loading or unloading must be done carefully, to balance, as much as possible, the weight on the boat, to avoid excessive twists on toggle bars and transfer bridges by the listing of uneven loads or transfer floats or steamers. Special provision should be made in the construction of the outer leaf of transfer bridge to allow the twisting or warping of the bridge to suit the list in the boat.

Transferring Passengers from Wharf Station to Ferry Boats or Steamers:

The ferry boat enters the slip or berth provided for landing and is brought against the generally short wooden transfer bridge. The ferry boat is then moored to the transfer bridge. The bridge is raised or lowered by means of hand winches mounted one on each side of the transfer bridge, and, when the proper level between boat and bridge floors has been established, small platforms are thrown over the gap or joint between the boat and the transfer bridge, and the passengers pass afoot from the ferry boat over the transfer bridge to destination. The teams, automobiles and other vehicles, are generally provided for in the central portion of the ferry boat, and move off the boat simultaneously with the passengers, separate passageways being provided for passengers on each side of the driveway. Where double deck ferry boats are used, auxiliary narrow steel transfer bridges with short wooden aprons are provided for receiving and discharging passengers from the upper deck to second floor in dock house or station.

The ferry boats are usually double ended to avoid turning; they are about from 160 to 200 feet long and from 50 to 60 feet wide, either single or double decks. The lower deck is divided into three parts, the central part for teams and other vehicles, and the two outside parts for passengers. The upper deck generally forms one passenger compartment. The modern ferry boats are operated by means of screws, while some of the boats of older construction are operated by side paddle wheels.

Transferring Freight in Cars to Floating Equipment or vice versa:

For transferring freight in cars to floating equipment similar methods are employed as for passenger car transfer, except that for freight purposes generally car floats without power are used.

These car floats have usually two tracks converging at ends to suit the spacing of the tracks on the transfer bridges. The car floats are toggled to the transfer bridges and properly moored, then the cars are run over the transfer bridges onto the car floats, taking care to keep the load on the float balanced as much as possible. When the float is loaded, or has all the freight that must be handled to a certain delivery point, the toggle bars are pulled back to the transfer bridge, and the float loosened from its moorings and moved by a steam tug boat. The transfer bridges used are the same as for the passenger car transfer already described.

Transferring Package Freight and General Merchandise from Boats to Freight Sheds and Warehouses:

For the flat-top or covered harbor barges or boats, the smaller package freight is generally wheeled on trucks over small platforms, resting on the edge of the pier and on the vessel to the freight shed or warehouses. The larger and heavier freight is hoisted by means of derricks located either directly on the vessel, or on the edge of the pier, and from there trucked or rolled to the warehouse, where it may be loaded on delivery wagons by means of a hoisting crane.

For the larger vessels or steamers, package freight is generally hoisted from the hold to the proper deck on the vessel, and then discharged to the pier either by sliding over a chute from the vessel to the edge of the pier, or by a derrick on the edge of the pier taken from the deck of the boat and lowered or carried to the pier, and from there either trucked or rolled into the warehouse for storage or for loading on delivery wagons, as the case may be.

Package freight that requires rail transportation may also be transferred from the boat or vessel direct to freight cars standing on car floats on the opposite side of the pier shed, or as may suit the facilities provided.

Transferring Package Freight from Pier Freight Sheds and Warehouses to Floating Equipment:

For the flat top barges and the roofed barges generally used for harbor business, the lighter pieces of freight are generally wheeled to the boat by hand trucks, the heavier pieces are lifted from the edge of the pier shed or warehouse to the boats by steam, or electric power derricks, or for special cases derrick equipped boats are brought to the pier shed, etc., to take the freight from the pier to the boat; this latter has the advantage in discharging the freight from the boat to warehouse where no derricks or lifts are provided.

For handling package freight and general merchandise, especially when certain freight of uniform packages is frequently handled, power conveyors may be employed in the warehouses between the second floor and the dock floor, such as elevators, automatic barrel elevators, spiral or inclined chutes. For delivering and handling package freight in long warehouses, moving platforms may be employed to good advantage in place of the usual trucking; in such cases, the inclined or spiral chutes from the second story should be so arranged that the freight lands on the moving platform and is carried to a point directly opposite the boat or vessel to be loaded, and there dropped automatically from the moving platform

and then transferred in the usual manner to the vessel. For large vessels, the top deck of which reaches considerably above the lower floor of the warehouses, freight from the first floor of the warehouse can be raised to the boat by means of stationary or movable derricks located on the edge of the pier shed, or by means of derricks located on the vessel to be loaded. From the second story the smaller package freight can generally be slid down on an inclined chute to the deck of the vessel, unless the boat is very large, in which case the freight is hoisted to the boat with derricks; movable narrow inclined moving platforms or conveyors leaning against the boat or vessel for handling smaller package freight may be employed.

For transferring ore or freight of similar character, special unloading machinery is provided, such as traveling hoists, cranes, or the more crude arrangement known as the telpherage system, using a derrick on the vessel to lower and raise the bucket to and from the hold of the vessel, and when above the level of the deck attach a rope to the bucket, operated by a hoisting engine over a mast, both located on the pier, pulling the bucket over to the pier, the derrick engine on the boat still having hold of the bucket but letting out its line to admit the moving of the bucket to the pier for dumping; this operation is reversed and repeated for every bucket load. Both the vessels and the pier are equipped with a number of hoisting engines, derricks and masts for working on several hatches to facilitate quick unloading.

The traveling hoists or cranes are provided with arms extending over the center of the boat or vessel; on these arms automatic grab buckets are operated; these buckets are let down into the hold of the vessel to grab a load of ore, etc., then they are hoisted to the level of top of open cars and run along the extended arm to shore, and dumped into the cars which stand on a track running along the dock, between the edge of the pier and the traveling hoist or crane. The cars when loaded, and empty cars for loading, are generally moved along the pier track by means of a cable and winches operated by small engines located on the pier.

At points where ore, etc., is received in larger quantities than can be loaded on cars at once, or on the great lakes where navigation stops during the winter months, and a winter supply of ore, etc., is delivered, long arm traveling cranes are provided, and the ore that is not to be loaded on cars for immediate transportation is stored on the so-called ore storage docks, the buckets taking the ore from the vessels are then traveling overhead beyond the loading tracks, and discharge the ore, etc., on storage piles, from where, when the material is required for shipping, it is again picked up by buckets operated from the crane and loaded into cars for shipment.

The Committee has been unable to obtain much data relative to handling of freight in cars and package freight at points where the range of tide is very large, as compared with the range of tide at New York Harbor and vicinity.

The following are some of the maximum ranges of tides at various seaports, harbors, etc., on the North American Continent, as recorded in the Tide Tables issued by the United States Department of Commerce and Labor, Coast and Geodetic Survey for the year 1908.

Elevating Ferry-Steamer "Finnieston," Glasgow Harbor, Scotland

New York, The Battery,	5.3 feet
Hudson Bay, Port Churchill,	15.5 feet
Hudson Strait, Ungara Bay,	38.5 feet
Labrador, Indian Harbor,	7.0 feet
Newfoundland, East Coast,	7.0 feet
St. Lawrence River, Murray Bay,	17.0 feet
	14.9 feet
ier,	27.5 feet
orge,	32.0 feet
Minas Basin,	50.5 feet
Railway,	47.0 feet
	11.8 feet
	10.5 feet
	10.9 feet
ve,	5.3 feet
rry,	6.2 feet
	8.5 feet
	5.6 feet
	5.5 feet
	3.2 feet
	3.0 feet
	8.0 feet
y,	1.3 feet
	1.6 feet

des, up to 10 feet, can be taken care r bridges for transferring freight on but for the greater ranges of tide or ield for favorable height of water to bridges, or arrangements made on the elivery tracks; in such cases the trans- er than usual and be suspended from counterweighted, etc., thereby provid- her method would be to have the trans- y and arranged to move up or down, s of track on the transfer bridge and tracks leading to the transfer bridge. transfer bridge for different heights only a moderate amount of freight is eld until the tide has reached a favor- f cars over transfer bridges, the track reasonable distance below the high loes not last long enough to make the

Scotland, the Clyde Trust has in serv- mer "Finnieston" 104 ft. long and 45 h a movable track platform on which atform is raised or lowered by eight ws of forged steel, and the screws are ast steel brackets which are supported atform is built of steel girders, closely y massive steel girders on each side nsion engine is used for operating the atform is constructed for a range of num range of tide at Glasgow Harbor

For the handling of package freight at piers where the larger ranges of tide are to be met, drop stages 30 ft. long are used at one of the New England piers; these drop stages are hinged at inner end and carried by a gallows frame at outer end; counterweights are arranged on this frame so that the stage is raised or lowered by hand. Movable brows are used to connect the outload of drop stage with the deck. Some of the drop stages above mentioned have been equipped with electric escalators; these are so made that a man and truck ride up the moving gangway without effort and proceed on the floors of the pier shed when the top of the escalator is reached. The movement of these escalators can be reversed if desired to use them for taking freight into the vessel. The stages are wide enough to allow ample gangway alongside the moving escalator.

At some European ports the ranges of tide are large, for instance:

Thames River, London,	20.5 feet
Liverpool,	25.0 feet
Cherbourg,	17.6 feet
Southampton,	12.8 feet
Havre,	22.5 feet
Cardiff,	36.2 feet

The docks are generally built in such a manner that the vessels are sheltered against large ranges of tide; these wharf systems are usually provided with a mean water and high water basin; the mean water basin, at entrance to wharves, is provided with sluice gates, these sluice gates being kept open during the time the tide is above mean water, which gives the vessels about six hours to enter the harbor. As soon as the tide reaches the level of mean water the sluice gates are closed and the water in the lower basin held at mean water level. The water in the high water basin, or basin where the vessels are docked, is generally held at the level of high tide by means of sluice locks located between the mean water basin and high water basin. High tide, as a rule, does not last long enough for vessels to pass from the low water basin during high tide; for which reason regular locks are provided between the two basins for transferring the vessels from low to high water basin. The vessels are docked in the high water basin, and discharge and take on cargo without being influenced by the tide, the water being held at a uniform level; see maps of West India Docks and Victoria Docks, London, England, in the appendix.

For loading and discharging passengers from the side of the vessels, floating stages or platforms are used at Westminster, London, England; these floating platforms, 240 feet long, 40 feet wide, are supported by 19 pontoons and connected with the shore by two transfer bridges 90 feet long and 7 feet wide. At Liverpool a floating dock is provided 1950 feet long, 80 feet wide supported by 112 pontoons and connected with shore by 7 transfer bridges 115 feet long and 18½ feet wide. At Dover, England, different heights of platforms are provided on the side of the pier or bulkhead; the levels of these platforms are reached by means of 8 ft. wide stairways. The passengers can be landed without difficulty at various levels of water. The range of tide at this point is 19 feet 9 inches; see sketch in appendix.

The European idea of handling freight at wharves where a large amount of package freight of all classes is handled, is to provide either a number of fixed swinging derricks along the edge of the pier to take freight from vessels to pier shed or vice versa, or one or more movable derricks operating along the water edge between the pier shed and the vessels; such fixed or moving derricks to be operated either by steam or electricity. The prompt and quick handling of freight from and to vessels is of the greatest importance and the success of the system of docks and wharves depends upon the proper kind and number of mechanical devices provided, and not too much attention can be given to the developing of machinery and apparatus for the more economical and prompt handling of freight on piers and from and to vessels.

F. E. Schall,
Austin Lord Bowman,
F. A. Knapp,
J. P. Snow,
E. E. Wilson,
Committee.

APPENDIX.

STRAITS OF CANSO RAILWAY FERRY.

The Strait of Canso, or, as in old Colonial French times Canseau, separates the Island of Cape Breton from the mainland of Nova Scotia; it may here be interesting to note that a railway in connection with the coal mines existed on the Island of Cape Breton, and a steam locomotive ran upon its rails, in the earliest period of railway history on this Continent.

That portion of the I. R. C. (formerly I. C. R.) extending easterly from New Glasgow to the shores of the Strait of Canso, was built as a private enterprise about 29 years ago; after being operated by the builders about three years, it was acquired and operated for about one year by the Provincial Government of Nova Scotia; it was then purchased by the Dominion Government.

The extension on the Island of Cape Breton dates from 1890 and 1891 and the complete line from Halifax to Mulgrave on the Strait shore and on the other side from Point Tupper to Sydney, is now owned and operated by the Dominion Government as part of the Intercolonial System. The railway and the larger facilities thus afforded for business and enterprise, has been of very great advantage to the towns of Sydney and North Sydney, and they have now grown famous as the homes of the Dominion Coal Company, the Dominion Iron and Steel Co., and the Nova Scotia Steel and Coal Company.

For some ten years or more after the construction of the Railway on the Island of Cape Breton, the transfer across the Strait was carried on by a scow or barge towed by a tug boat, in fact, the builder of the road had to inaugurate the scow ferry in order to build the road, and, after the road was taken over by the Dominion Government and became a part of the I. R. C., the work of transfer continued to be done by the scow, and a steamer was especially built, with cabins and otherwise adapted, for the combined purpose of towing the barge and carrying the mails and passengers. The scow lashed to the steamer's side was capable of carrying over

four freight cars, but the mails and passengers with their baggage had to be transferred from the cars to the steamer, and, after crossing, again transferred to cars. Mail cars and passenger cars were not carried on the scow.

As the works of the Dominion Coal Company, and of the Dominion Iron and Steel Company and other enterprises, developed, and the towns of Sydney and North Sydney became more populous, it was imperative that a more rapid and businesslike method of transfer should be provided, and that passengers and mails should be carried across without discharging, and the establishment of an efficient railway car ferry was decided upon. Before arriving at this conclusion much consideration was necessary, and the question of the relative merits, all things considered, of a bridge and of a ferry steamer, and how large a vessel and how designed, had to be discussed and fully considered. The waters of the Strait of Canso are rather peculiar and their successful navigation at all times and under all conditions of tides and weather, needed some study; the Strait is at some points very narrow, and at the narrowest place, between Cape Porcupine, and MacMillans Point on the opposite side, is only some 2,500 feet across, and a bridge was considered by some competent engineers to be practicable; the probable cost, however, at any rate until further developments of transfer needs should render a train ferry incapable of handling the business, was thought prohibitive.

A suitable steamer was accordingly ordered by the Minister of Railways and Canals, from the ship building firm of Sir William Armstrong, Whitworth and Co., of Newcastle-on-Tyne, who had built some very successful ice vessels, and the Chief Engineer of the Intercolonial Railway (Mr. W. B. MacKenzie) was instructed to prepare plans for transfer bridges, and arrange for the necessary transfer facilities between the steamer and the terminals, on both sides of the Strait, viz.: at Mulgrave on the Nova Scotia side, and at Point Tupper on the Cape Breton side.

There were of course several precedents for such a train transfer service, both of greater and less importance, but as probably in no two cases do exactly similar conditions exist, so it became necessary to study the subject with special reference to the particular requirements involved.

The tide enters the Strait around both ends of Cape Breton Island and its movements under the influence of the wind and the peculiar formation of the shores produce very erratic currents. So much is this the case that it is quite possible to row out into a current which is flowing in one direction and after drifting with that current for a while row over into another current and drift in an opposite direction back again. It also happens at times that while the regular rise and fall take place, the direction of the whole flow may be the same for days together; the velocity of the tidal current is about four miles per hour and at times is much more.

The Strait itself does not freeze over, but a large part of St. George's Bay at its northern end does; the ice thus formed in St. George's Bay is generally kept locked back by a jam which usually forms at the narrow part between Cape Porcupine on the main land of Nova Scotia, and MacMillans Point on the Cape Breton side. After this jam is well formed not much trouble is experienced in transfer work until the jam breaks in the Spring, when the Strait

View of Transfer Bridge and Ferry Steamer "Scotia" at Mulgrave, Nova Scotia.

is then filled with ice of various thicknesses and much of it quite heavy, and in large fields, which keeps drifting about, back and forth, up and down the Strait, and is carried by wind and tide in various directions in the most erratic manner. This goes on for several weeks, until a good strong and prolonged northerly wind carries it quite out into the Atlantic Ocean.

The rise and fall of tide ranges from about 5 ft. at neap, to some 6½ ft. at spring tides. It thus became necessary in designing the boat that she should be able at all times to force her way through and among the ice, under all conditions of wind and tide. The vessel built for the purpose, although at the time the subject of some adverse criticism, has nevertheless proved herself well suited for the work.

The description of the Ferry Steamer "Scotia" is as follows:

Length over all, ...282 feet
Extreme breadth, ... 48 feet
Width at lead water line, ...43 feet 6 in.
Draft with 900 tons cars, coal, etc., ... 11 feet
Indicated H. P., ...2000
Rail head to load water line, ... 7 feet, 6 in.
Rail head to light water line, ...10 feet, 11 in.
Two engines triple expansion; cylinders, 17½ in.-28 in. 45 in. diam.
Length of stroke, ... 27 inches
Boiler pressure, ...160 lbs. per square inch
Cost in England, ...about $230,000
Additional cost of delivery at Mulgrave about $7,000

The vessel has eight watertight compartments.

Two propellers, one at each end.

Each engine with its shaft and propeller is run independently, but the shaft is provided with a coupling at the center and can thus be made continuous if for any reason desirable to do so.

There are three tracks on the steamer.

She carries twenty-one freight cars or 9 90-ft. first class passenger or sleeper cars. With one outer track fully loaded she lists about 9 degrees from the horizontal.

The extreme range of variation in elevation between rails on bridge and rails on boat is of course the difference between light and loaded draft of steamer, plus the extreme rise and fall of tide, and is equal at spring tide to nearly ten feet, or (10 feet, 11 inches-7 feet, 6 inches) + 6 feet, 6 inches; the ordinary rise of tide, however, is perhaps not over 5 feet, 6 inches, which would make the ordinary difference above named say about 8 feet, 11 inches.

This difference in elevation was among the first things to be considered in designing a transfer bridge to connect the fixed rails on the land terminals with the varying elevations of the rails on the boat, it has also to be kept in mind that to the difference in elevation already named there must be added the tipping down of the end of the boat by the entering theron of the loaded cars, and also the list or keel sideways caused by the loading of either one of the two outer tracks.

Some experiments were made to determine the permissible amount of angle between rails carrying the forward truck and the rails carrying the rear truck of a car. It was, however, soon discovered that the limiting point was not at the trucks but at the vestibule door of the sleepers, and of the first-class cars.

View Looking Through Transfer Bridge at Mulgrave.

Same as Above, but Farther Off.

View of Point Tupper Dock from Wheelhouse of Ferry Steamer.

View from Wheelhouse of Ferry Steamer Showing Passenger Cars on Two Outer Tracks.

Ferry Steamer is Being Tied Up at Point Tupper Bridge. Shunter is Coming Down the Bridge to Haul Cars Off.

Passenger Train Has Been Run Off of Steamer at Point Tupper and Backed into Station on the Right, Ready to Start for Sydney.

The first impressions were that 100 ft. or so, would be a sufficient length of bridge to meet the case, but it finally came about that nothing less than 200 ft. from the fixed rails to the boat rails would answer; this length it was found necessary to cut into three sections, viz., an inshore section or span of 100 feet, an intermediate section of 50 feet, and an outer section of 50 feet, (see accompanying photo and blue prints). This, as will also be seen, involved three gantries, one to suspend the adjoining ends of the 100 feet inshore span and the intermediate span, one to suspend the adjoining ends of the intermediate and outer span, and one to suspend the outer end of the outer span. The last named gantry is at a point 15 ft. from the extreme end of the outer span so as to allow the boat to come well under its end while receiving her load. The inshore end of the 100 ft. span swings on links hung on pins contained in suitable housing boxes, and strong spiral springs are provided to prevent any serious shock which might occur from the impact of the boat on coming in. The inshore and intermediate spans, and the intermediate span and outer leaf, are also articulated at their junctions.

A gantry frame is provided at each articulation of the inshore span and of the outer leaf, with the intermediate span, and one also at 15 ft. from the outer end of the outer leaf; these gantries are carried on square columns each composed of four angles connected by lattice bars. Counterbalance weights working up and down inside these columns carry the entire dead load occurring at each point of articulation, the outer gantry and its counterweights carrying the dead load of the outer leaf occurring at its point of suspension.

The counterweight at each column of the inshore gantry amounts to 27,000 lbs.

At each column of the middle gantry the counterweight is 32,000 lbs.

The counterweight at each column of the outer gantry is divided into two parts, the main portion at each column weighing 28,000 lbs. and the minor portions 10,000 lbs. This minor portion of the outer gantry counterweights is called the auxiliary counterweight. These counterweights represent in each case only one-half of the dead load reactions, one end of each suspender rope, excepting those of the auxiliary counterweights, being attached directly to the cross girder of gantry frame. The operation of the divided counterweights of the outer gantry is thus described: When the steamer is coming into the bridge the entire counterweights are allowed to act, and together are sufficient to quite overcome the dead load of the outer leaf occurring at the suspension point, the outer leaf is thus raised clear, so that the bow of the boat may pass under it, then, when the boat has been placed in the correct position, the smaller or auxiliary part of the counterweight is raised away from the main part, and some five tons or so, of the outer leaf dead load, is allowed to come upon the boat and it is thus kept in close and continuous connection as the boat rises and falls with the action of the water, and of her increasing draft caused by the gradual additions to her load. The falling velocity of the auxiliary counterweight is controlled by an automatic mechanical brake, a full description of which might be interesting but would be rather lengthy.

The dead load reactions at the two gantries are, as has been described, taken up by the counterweights, but the live loads occurring at these points are taken by cast steel screws 6 inches in diameter one inch pitch and 14 ft. long, working through gun metal sleeve nut bushings in cut bevel gears. These gears and their drivers are operated simultaneously through a system of horizontal and vertical shafting, which derives its power from a low frame double cylinder reversing steam engine, working in a power house situated on the shore at the outer gantry, near the middle of the outer leaf; cylinders 8½ in., stroke 10 in.

The steel screws are operated simultaneously by proportional gearing, so that the inshore 100 ft. span and the 50 ft. intermediate span, in rising or lowering, are kept at the same continuous incline or parallel.

The action of the outer leaf is independent, and is controlled entirely by the auxiliary counterweights, the ends of their suspending ropes being wound upon a drum situated at the middle of the outer gantry, and operated by means of a pair of cup bevel frictions in the engine house, the auxiliary counterweights being lowered upon the main counterweights cause the outer leaf to rise, or if raised away from the main counterweight permit the leaf to fall into position on the bow of the boat; these motions are produced by the reversing of the engine, through a line of vertical and horizontal shafting with mitre gears at the tops of the columns.

Rollers at the junction of the connected spans and at the suspending point of the outer leaf, and moving between guides secured to the inner faces of the gantry columns preserve the lateral integrity of the vertical motions of the leaves or spans and keep them steady when in position.

A very essential and somewhat interesting feature of the outer leaf remains to be described, viz.: the twisting of the leaf to accommodate the list or careen of the boat, caused by the loading of one of the outer tracks; this, as has been mentioned, will at times reach, or perhaps exceed, 9 degrees. Now as the inner end of the leaf is maintained in a horizontal position, this twist of 9 degrees had to be provided for as it would have been too much to expect so much twist in a length of fifty feet without some special provision. After some thinking it was finally decided to construct the leaf with steel "I" cross-beams between each pair of its four longitudinal girders, and to provide these I-beams with trunnions at each end. These trunnions consisting of steel castings bolted to the webs of the beams, are formed with a bulb bolted to the webs of the beams; they are formed with a bulb enlargement which fits and can wabble in a hole drilled through the webs of the girders, the webs being suitably thickened at the line of the holes; the rails of the three tracks running over these I-beams are carried on steel plates clamped to their upper flanges, the plates being so secured to the beam flanges as to admit of the necessary slipping both laterally and longitudinally.

It was thought desirable to build the boat as a double ender, and the rudders, one at each end, are provided with strong locking pins; the rudders are very strong and adapted for the onslaught when it is necessary to attack heavy ice; but, as the track approaching Mulgrave is on a steep grade, the train is run a half mile or so beyond the station to Pirate Cove, where the Round

House is also situated, and is then switched back on another downgrade to Mulgrave station, and enters the transfer bridge and ferry boat, backwards, then the boat enters the Point Tupper Dock with the same end forward as at Mulgrave; the train on arriving at Point Tupper is thus heading in the right direction for continuing the journey to Sydney. This arrangement also permits the use of strong buffer posts on each track at one end of the boat, and these, with the addition of heavy rail clamps against the wheels, and strong stopping chains with heavy spiral spring boxes in them to prevent jerking shocks, furnish ample safety to the train while crossing.

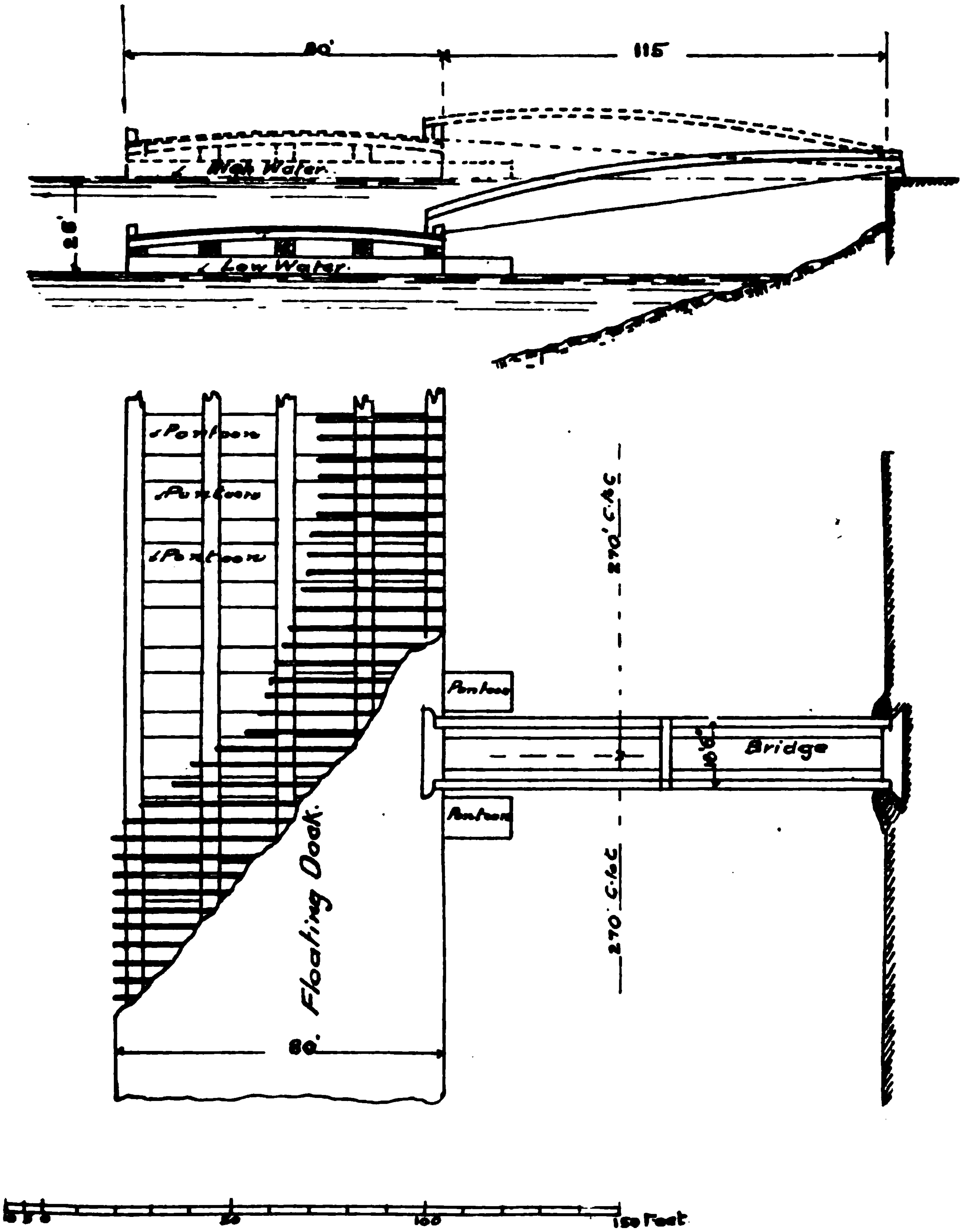
The dock at Mulgrave is nearly parallel with the course of the Strait while the dock at Point Tupper lies nearly at a right angle with its course. The boat backing out from Mulgrave dock is thus required to make a quarter turn while crossing. The distance between docks is 1.3 miles, the time occupied in transfer from the arrival of the train at either side to the starting again on the other side is ¾ of an hour, the boat crosses in about ten minutes but the docking and tying up depends somewhat on the tide and currents at the time, and if there is much ice to contend with the crossing may be more or less retarded.

Some difficulty was experienced in building the docks, there being very little driving ground for piles, the substratum being rock, a large quantity of heavily ballasted cribwork had to be used both in preparing the wharf backing for the spring piles, and also in building large blocks to divert the course of the ice when rushing up and down with the tide.

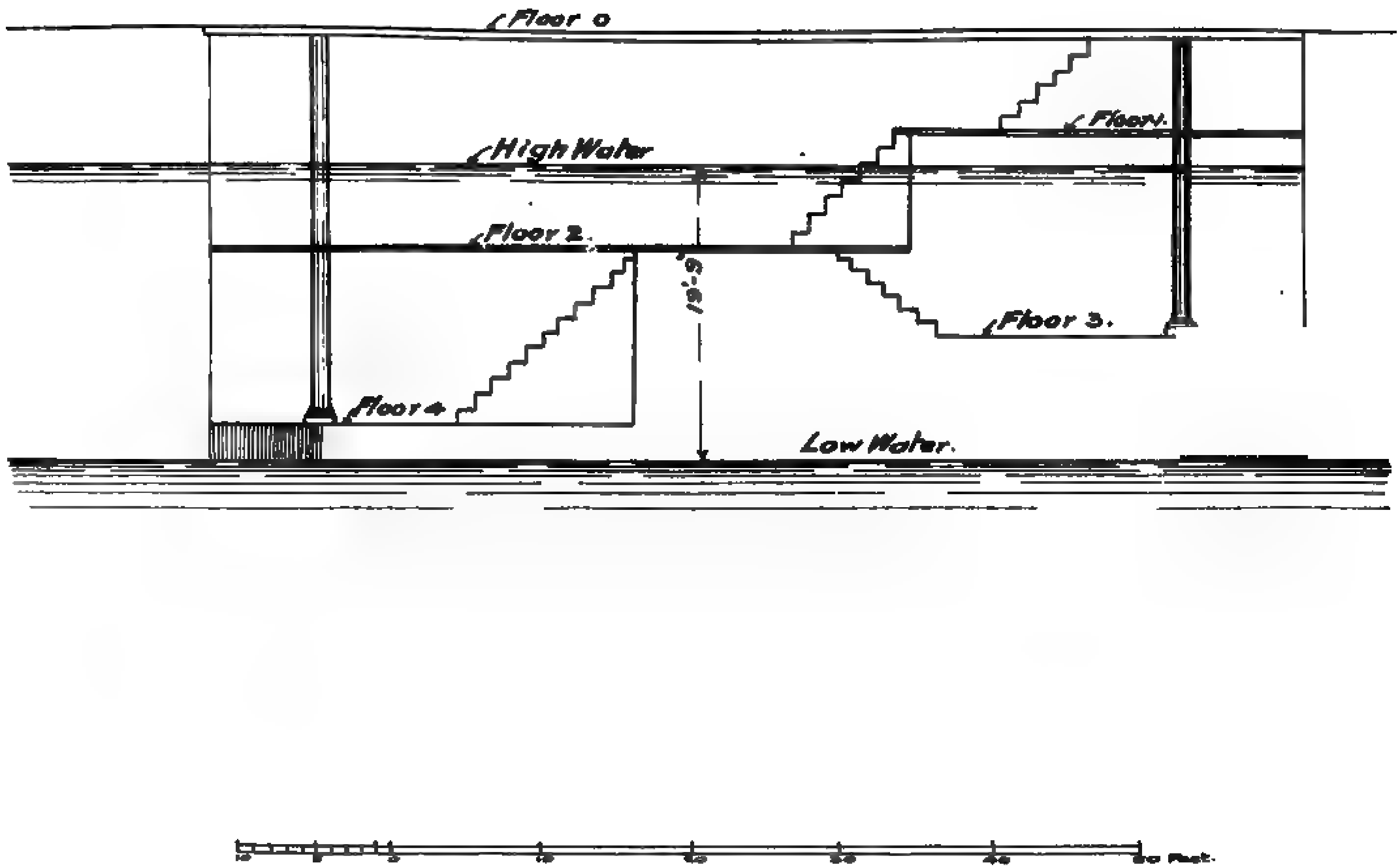
The steel superstructures of the transfer bridges were constructed and erected complete by the Dominion Bridge Company at Montreal, the designing and general details being the joint work of the engineering staff of that establishment in combination with the Chief Engineer of the Intercolonial Railway and his assistants, and the quite satisfactory operation of the entire structures, as well as of the Ferry Steamer "Scotia," has proved highly gratifying to all who participated in the work.

Anv information as to cost or details that may be wished would doubtless be readily furnished by the courteous and accomplished General Manager of the establishment above named, Phelps Johnson, Esq., C. E., or by the Chief Engineer of the Intercolonial Railway, under whose administration the works were executed.

(SIG.) JOHN FORBES.



Landing Arrangements for Passengers at Liverpool England.



Arrangements for Landing Passengers at Dover, England

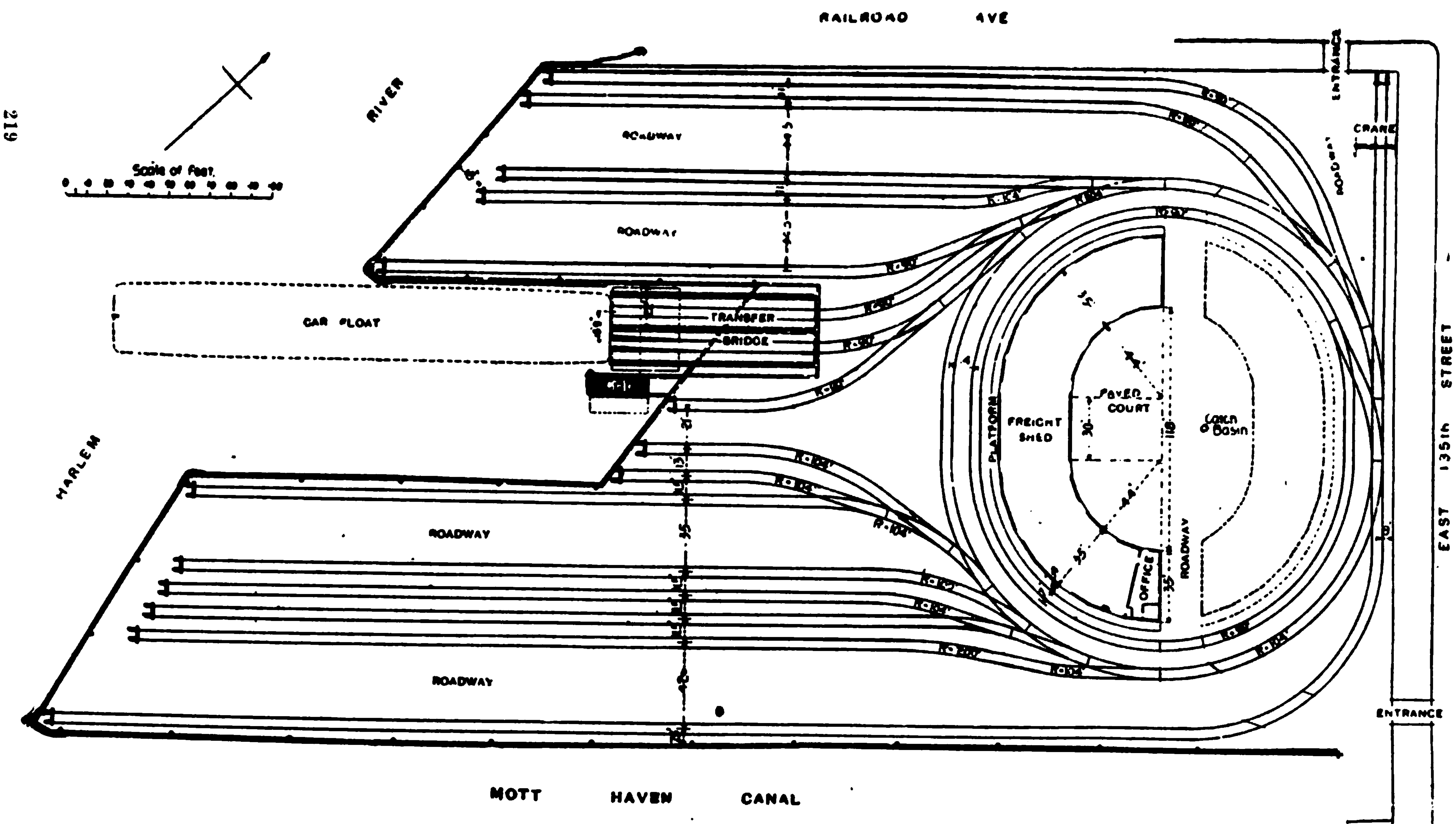
Western Part of Old Victoria Docks - London

Eastern Part of Old Victoria Docks - London

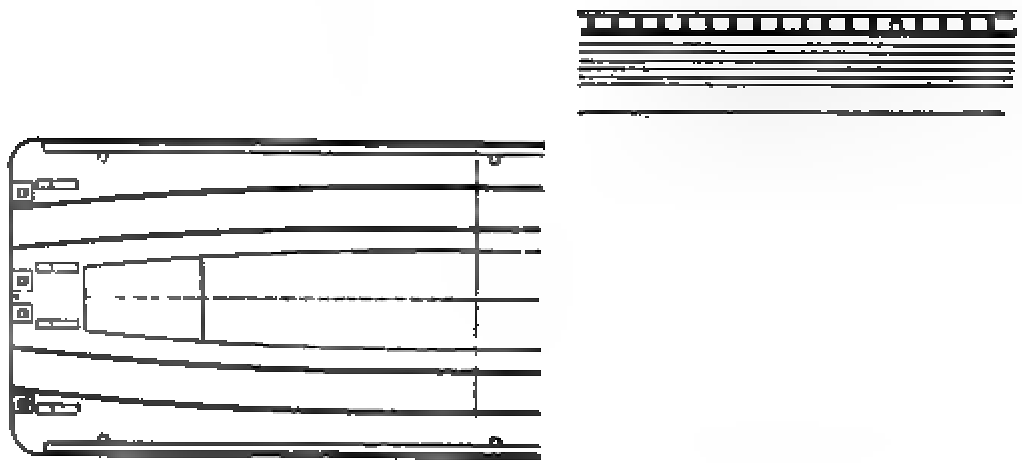
West India Docks - London

SPECIAL DELIVERY CAR TRANSFER STEAMER.

Patented by Walter G. Berg.



Harlem Transfer Co.'s Freight Terminal, New York City.



Plan of Car Float.

Plan of Car Float

DISCUSSION.

President.—We have a very good report on this subject—in fact an excellent one—one of the best that we have ever had. It deals with a subject of considerable importance, especially to the eastern roads.

Mr. A. S. Markley.—The committee has certainly put a good deal of time and thought on this. I have not had very much experience in line with this subject, but from reading the report it seems to be one of the best we have ever had of that kind, and should be of considerable value to those having docks and wharves to maintain.

President.—The report is so thorough that it is pretty hard for most of us to add anything to it at the present time.

XI.

RAILWAY ENGINE HOUSE CONSTRUCTION.

REPORT OF COMMITTEE.

To the American Railway Bridge and Building Association:

The construction of engine houses has had a steady and gradual development, entirely in conformity and keeping with the development and increasing size of the locomotive. Most of the larger railroads are now building them 85 to 90 feet or more in depth, which also requires a corresponding increase in the length of turn tables, pits, etc.

Concrete is almost universally used for foundations, some roads carrying the concrete work to the height of the window sills, while a few have ventured to make use of reinforced concrete for the entire body of the structure. Some members have indicated a preference for brick walls on account of being easier to repair in case of having been damaged by an engine. It is difficult to foretell the result of an engine going through the rear wall of a reinforced concrete engine house, or tearing out a post, yet such is liable to be the case at any time.

A greater amount of attention has been accorded engine-house construction during the past few years, with reference to heating, lighting and ventilation. The most difficult problem, and one which figures largely in the matter of maintenance repairs, is that of smoke jacks. It is quite apparent that the large-mouthed jack has come to stay, and is rapidly taking the place of the small drop jacks which are commonly made of cast iron or tile. This style of jack is built up of wood or composition board, the composition material being manufactured of cement, asbestos and like ingredients. This design not only carries off the smoke and gases to better advantage, but permits of a wider range in the spotting of engines. Experience has taught that as little iron as possible should be left exposed in the construction of engine houses on account of the rapid deterioration due as a result of burning coal and coke.

The matter of roof covering is very important, and in recent years the manufacturer is making an effort to produce a composition covering of light structure, which is put on the market in rolls and requires simply putting in place and fastening, pretending to replace the old style tar and gravel roofs. These preparations can be used to good advantage on roofs which have a considerable slope where tar and gravel are not practical, but it will require time and experience to decide which is the cheapest and most durable for flat roofs.

Where a flat roof is used the monitor style of construction as shown on pages 135 and 137 of the Fourteenth Proceedings affords an excellent means of lighting, besides additional ventilation.

Modern engine houses are also being better equipped with heating, sewerage, water and washout systems, etc., in recent years.

REFERENCES.

We make reference to the following articles in technical magazines and in our own Proceedings, which contain much information in regard to details of engine house construction:

1. Roundhouse—Intercolonial Ry. of Canada, *Railway Review*, March 12, 1904.
2. Union Pacific Ry. Shops, *Engineering News*, May 9, 1891.
3. Comparison of Circular and Rectangular Engine Houses, *Engineering News*, March 3, 1904.
4. Brick Floors, Eighth Proceedings B. & B. Assn., page 102.
5. Smoke Jacks and Ventilation, Eighth Proceedings B. & B. Assn., page 112.
6. Turntable Construction, Eighth Proceedings, page 184.
7. Concrete Engine House Construction, Fifteenth Proceedings, pages 98 to 107.
8. Best Forms of Construction for Engine Houses, Fourteenth Proceedings, pages 128 to 189.

The committee sent out a number of letters of inquiry on this subject, and we think best to embody extracts from the same in the report. A few drawings of modern designs are also submitted.

EXTRACTS FROM LETTERS OF INQUIRY.

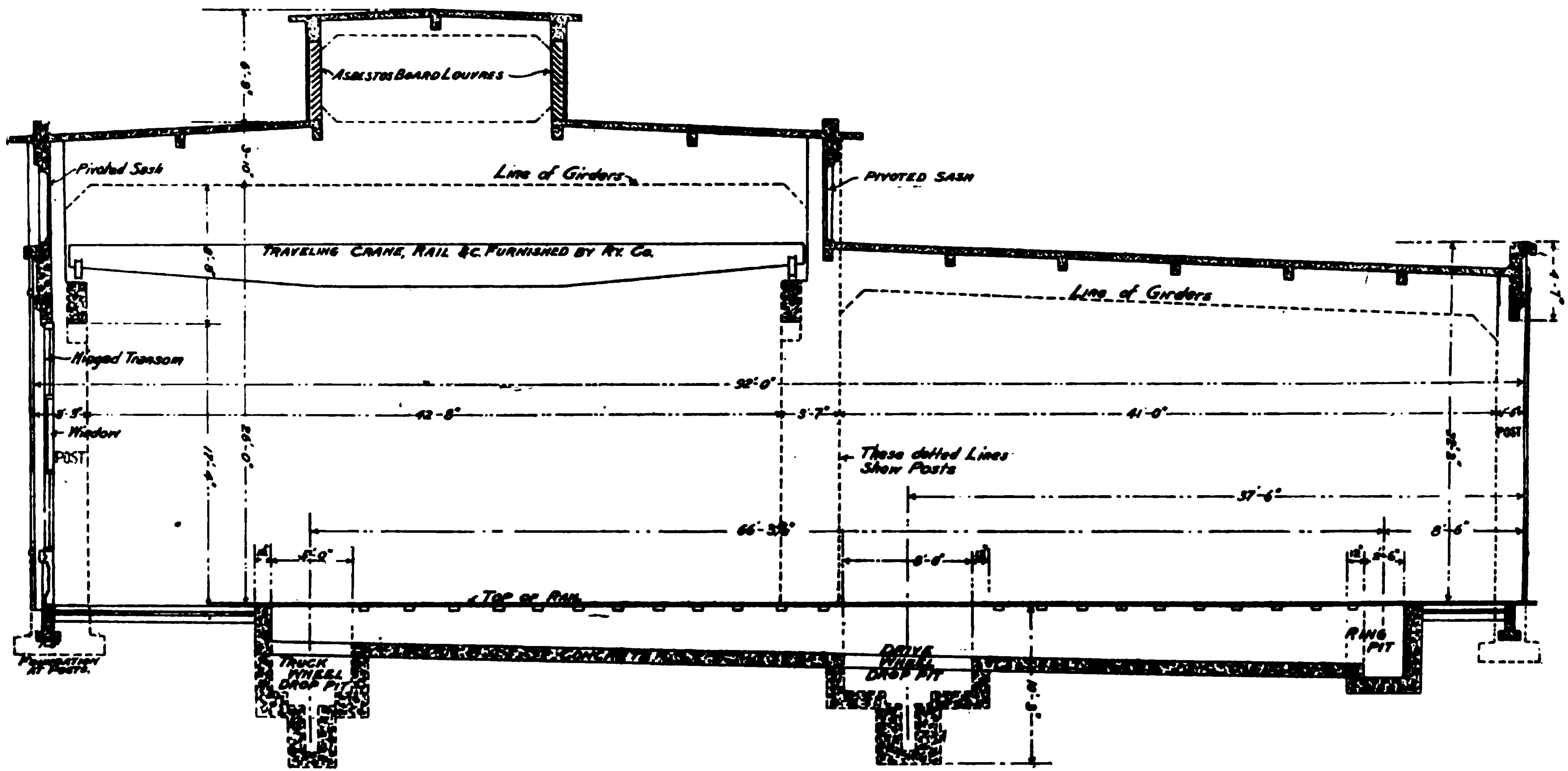
J. F. Parker, Atchison, Topeka & Santa Fe Ry.:

The A., T. & S. F. Ry. recently constructed a concrete engine house at San Bernardino, Cal., which is standard design for our coast lines. The cost of this house with pipe lines and sewers, and everything pertaining thereto, was $158,000. The house consists of thirty-five stalls, including traveling cranes, drainage, piping, concrete floor and pits. Rails on pits are fastened with rail clips. This is a complete building in every detail.

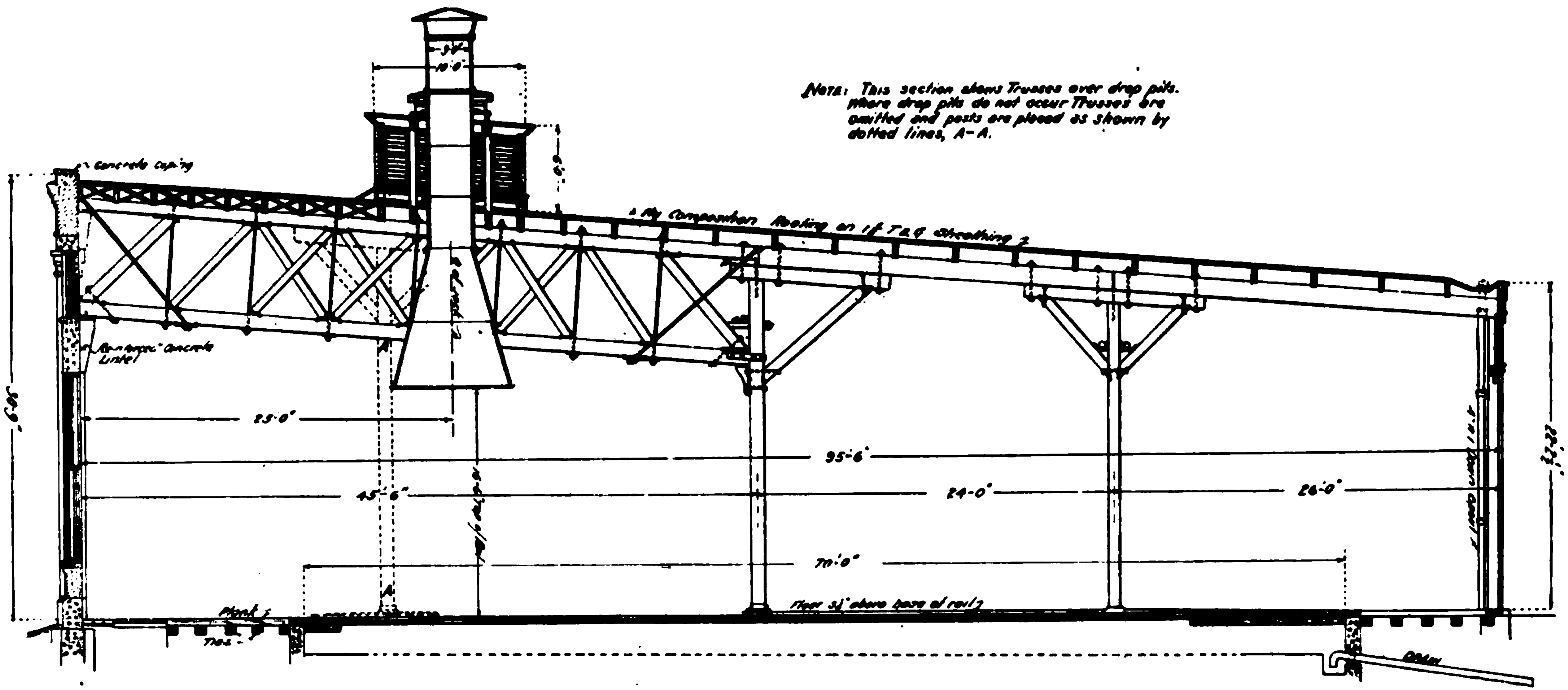
A. O. Cunningham, Wabash R. R.:

Forty-two stall frame engine house recently constructed by the Wabash Railroad at Decatur, Ill., cost $84,500, as follows:

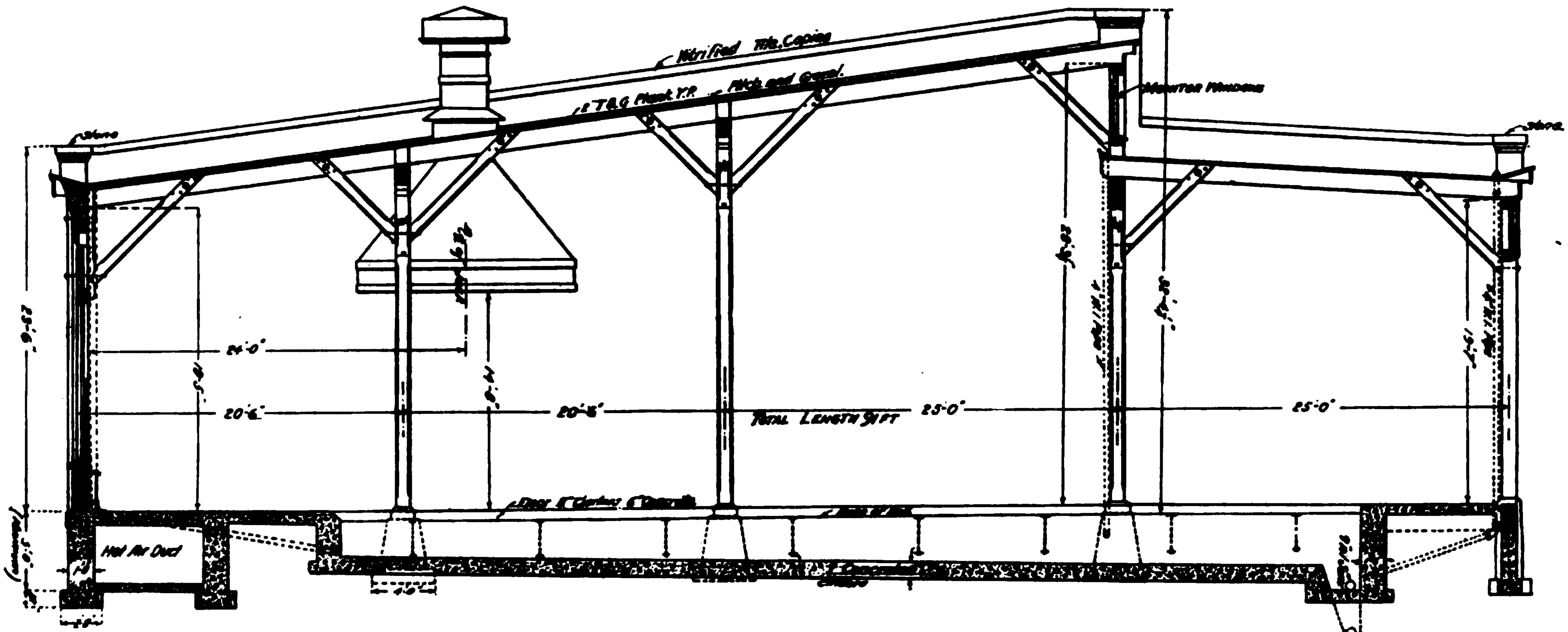
Engineering,	$ 1,000.00
Grading,	600.00
Building (contract),	58,100.00
Roof,	2,000.00
Steam Heat, piping and vacuum pump,	6,220.00
Smoke Jacks,	2,100.00
Electric wiring and lights,	1,000.00
Telpher hoist inside house,	1,000.00
Washout system,	6,900.00
Drainage and sewerage system,	1,950.00
Rail and track fastenings inside of house,	1,675.00
Tracks between house and turntable,	1,955.00
	$84,500.00



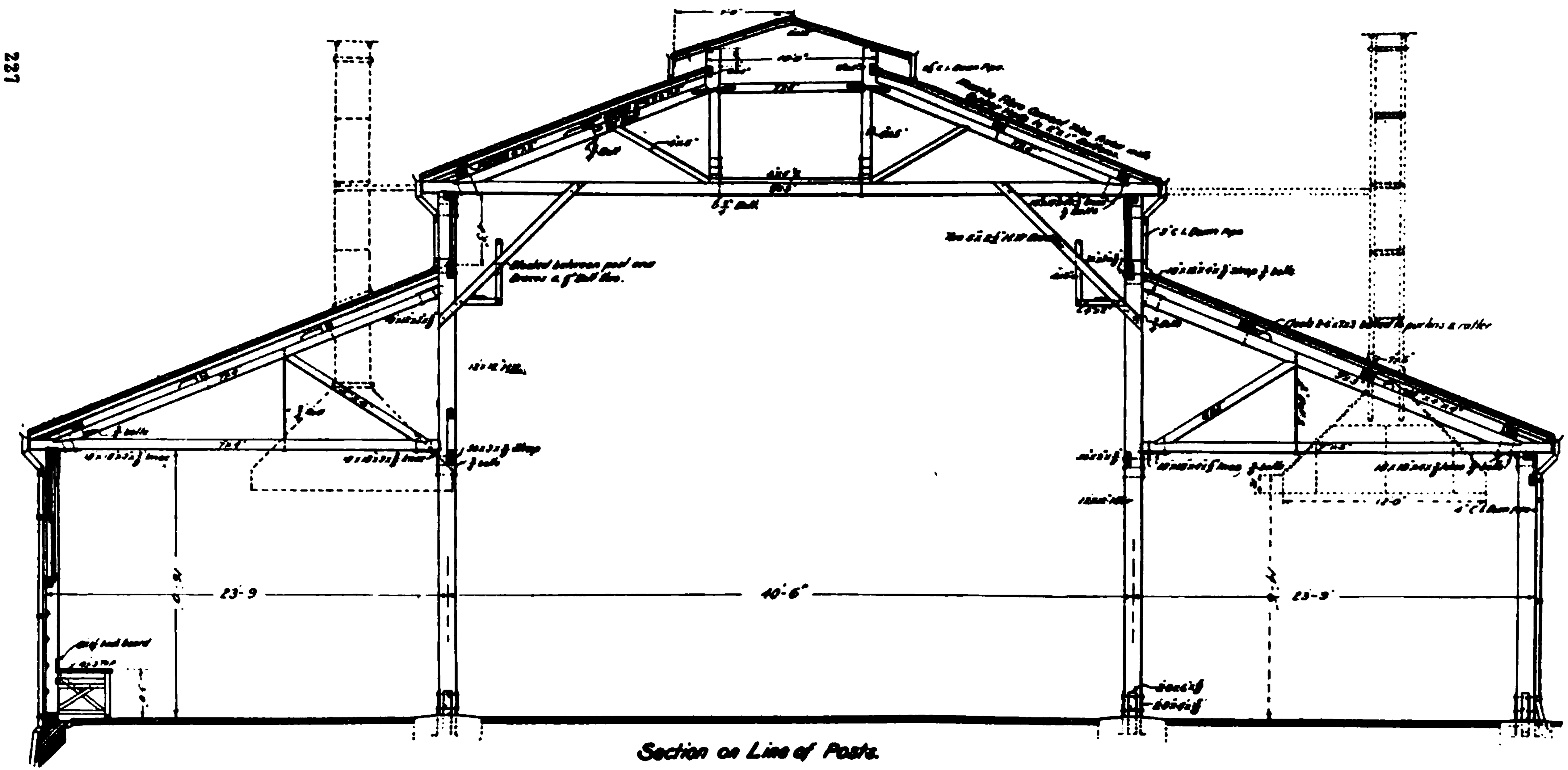
LONGITUDINAL SECTION OF STALL
Reinforced Concrete Engine House, Santa Fe Coast Lines.



Section of Stall, 95-ft. Engine House, B. & O. R. R.



Standard 90-ft. Engine House N. Y. C. & H. R. R. R.



Section on Line of Posts.

Engine House, New South Wales Govt. Railways, Australia.

S. C. Tanner, Baltimore & Ohio R. R.:

At Riverside, Baltimore, the B. & O. R. R. recently built two engine houses of frame and reinforced concrete, twenty-five stalls each, with concrete drop and engine pits complete. The engines enter the house head on, which locates the machinery part of the engine at the widest floor space and at the highest point of elevation, to admit light and ventilation for machinists in making repairs. The floor is of vitrified brick laid on edge. The smoke jacks are built of cast iron with a hood on the inside of the house eight feet long and thirty inches wide. The entire building is heated with steam and supplied with water and necessary drainage. The roof is covered with four-ply composition roofing on 1⅝in. tongued and grooved sheathing. Rolling doors of wooden slats are used instead of framed doors on hinges.

R. H. Reid, Lake Shore & Michigan Southern Ry.:

Forty-stall engine house at Ashtabula, Ohio, now being constructed by the L. S. & M. S. Ry., is frame with concrete foundations. Estimated cost is $3,300 per stall. Smoke jacks, made of wood and plastered with asbestos, will cost $175 each.

John Ewart, Boston & Maine R. R.:

Our standard brick engine house is 75 feet deep and costs complete about $1,600 per stall. The heating, four 1¼in. pipes, two sides and one end (which is included), costs from $90 to $100 per pit, and the drain (also included), about $45 per pit. Roof, five-ply tar paper and gravel. Have used the Dickinson and also wooden smoke jacks, and a few made from asbestos board. Floors are paved with brick laid on edge and grouted. Timber cap on pits for rails. We are working on plans for an 85-ft. house which will be different from anything that we now have.

James Fraser, New South Wales Government Railways:

Twenty-stall circular engine house, including ash pits and brick floors, estimated at $45,000.

E. G. Storck,
S. C. Tanner,
W. E. Harwig,
John Ewart,
Committee.

DISCUSSION.

Mr. A. S. Markley.—On the first page of this report reference is made to putting on roof covering of ready composition roofing. I have had a good deal of trouble with roofs covered with that kind of material. The entire roof is dependent on one seam with cement in it. Our experience is that the best thing is a built-up roof of felt, tar and grav-

el, and that it gives much better service than a ready roofing.

Mr. Fake.—I would like to ask Mr. Markley on how steep a pitch a built-up felt and tar roof can be used successfully.

Mr. Markley.—I do not want to be understood as throwing cold water on composition roofing where it is to be used on roofs of one-half to three-fourths pitch, but simply where it is used on flat roofs where the water can back up between the seams, and cause leaks when they become loose.

President.—Is there any representative here of the New York Central & Hudson River R. R., who can give us any further information as to their standard engine house, an illustration of which is shown in this report? I have seen this engine house myself, and it appears to me to be a pretty well designed structure. (No reply.)

XII.

PAINTING: BEST PAINT TO USE; EFFECT OF SALT WATER; USE OF COMPRESSED AIR IN PAINTING AND CLEANING IRON.

REPORT OF COMMITTEE.

To the American Bridge and Building Association:

Early in the season circular letters were sent to several members of the Association, some of which very kindly sent replies, all of which we present in full.

COPY OF CIRCULAR LETTER.

Boston, March 17, 1909.

In order that the committee on subject No. 12 may be able to make a full and complete report to be submitted to the Convention to be held at Jacksonville, Fla., October next, they desire your coöperation, and submit the following questions, which, if you will kindly answer, and also add any information you think will be of interest in making this report, will be very much appreciated by this committee.

1. What do you consider the best paint to use for the preservation of steel and iron structures where exposed to fumes from coal and coke from locomotives?

2. What effect does salt water have on steel and iron where wholly or partly submerged all or a part of the time?

3. What has been your experience in the use of compressed air in painting and cleaning iron and steel structures?

EXTRACTS FROM LETTERS RECEIVED IN REPLY.

J. P. Snow, Chief Engineer, Boston & Maine R. R.:

1. I find that paints based on vegetable oils and gums are better than those based on mineral oils, for exposure to engine gases and open weather conditions. Under water, mineral oils are better than vegetable. The pigment affects the result but little, provided it is fine and free from active chemical agents in itself.

Graphite of the best brands has given us good service. The lead paints, if pure, are good. Red lead tempered with white lead, graphite or lampblack is excellent for a first coat.

Some of the ready mixed paints are good, if not superior to the above; Harrison Bros'., Edward Smith's, Tock Bros'., and Jones' paints are very good in my opinion. The first two are based on gums. A late production of Harrison Bros'. compound with a preparation of chromic acid is worthy of trial.

No one paint is best for all locations, and the best for a given place will do but little good unless the iron is perfectly free from rust and scale and perfectly dry when painted. Experiments under national auspices are now under way at Havre de Grace and at Atlantic City, but the chances are that all good paints will prove nearly equal.

2. My experience goes to show that steel does not corrode so rapidly in salt water as when exposed to engine gases or to brine drippings in the open air. I can not explain the reason for this, but it seems to be a fact that the scale adheres under water more firmly than in air and serves in a way to protect the metal.

3. My experience with sand blast operated with compressed air shows that it is about the only way by which iron can be prepared to receive paint perfectly. If new work is followed up every year for five or six years by painters it can be saved from corrosion, but if left a few years it is very difficult to stop serious rusting without the sand blast. If sand-blasted, the iron can afterwards be kept in good condition by ordinary painting if followed up closely enough. As to painting with compressed air by spraying: it is not worth while on metal bridges; the surface to be painted is too small.

R. P. Mills, Supervisor of Buildings, New York Central Lines:

1. One or more coats of pure red lead mixed with pure raw linseed oil and japan, in proportion as follows:

200 lbs. pure red lead,

80 gals. pure raw linseed oil,

1¼ gals. japan, free from benzine or turpentine mixed in the following way:

A suitable quantity of the pigment shall be permitted for twenty-four hours to absorb its full capacity of raw linseed oil; thereupon, it shall be worked or stirred to the consistency of a stiff paste. As much of this paste as may be needed for the next six hours or less shall then be thinned out with the requisite amount of oil required to give the ultimate proportions as stated in the formula. In no case shall the paint mixed ready for use be more than six hours old at the time of application. This should be followed by one coat or more of Dixon's graphite paint, or of the following formula:

220 lbs. lampblack ground in pure linseed oil.

50 lbs. asphaltum varnish made from pure high grade Egyptian or Utah asphaltum, properly combined with pure linseed oil and turpentine, free from benzine, tar, resin, boneblack, etc.

15 gals. pure raw linseed oil, refined,

15 gals. pure japan, free from benzine or turpentine.

2. The effect is very injurious, and to prevent I have found a heavy coating of grease, wrapped with a two-ply tar paper, then coated with tar, to be very effective. My experience with all kinds of paint has failed to give good results, and the above mentioned I have found to be very effective, and protects the life of steel or iron indefinitely.

3. I have never had any use for compressed air for painting, although I have found it very effective for cleaning iron, steel and stone work with the sand blast.

G. Aldrich, Bridge Supervisor, New York, New Haven & Hartford R. R.:

1. The best preservative that I have ever had anything to do with is a good quality of graphite paint. It stands the gases better than anything else I have ever had occasion to use.

2. I think we have no structure of this description. I had, however, some years ago charge of an iron float bridge which was submerged in salt water several times during the day for short intervals, and the only protection it had was a good quality of graphite paint which gave good results.

3. I have never had any experience with the use of compressed air in the painting or cleaning of iron and steel structures, but it seems to me that the sand blast is the proper thing to use for cleaning, and I am of the opinion that where there is a large surface to paint it could be done much cheaper with compressed air than by hand.

R. H. Reid, Supervisor of Bridges, Lake Shore & Michigan Southern Ry.:

Referring to your circular letter asking for information in regard to painting: I hand you herewith such as I have been able to obtain from our master painters. Kindly note the reference made by Mr. Phelps to proceedings of the Association of Maintenance of Way Painters. Those desiring additional information would do well to consult the publication.

A. B. Phelps, Master Painter, L. S. & M. S. Ry.:

1. I do not believe there is any "best paint"; any of a dozen or more makes are of about equal value for the finishing coats, varying somewhat owing to location and conditions, although for all-round work there is nothing better for first coat next to the iron than red lead properly applied; I would include in this all ferric structures.

2. I have never had experience with steel submerged in salt water, but salt in all other conditions which I know of (drippings from refrigerator cars, urine, etc.), causes steel to corrode badly, with an uneven surface, creating hard scales or scabs, which, when removed leave small depressions, somewhat like the bowl of a spoon, and if neglected will eat away and weaken the structure.

3. I have never had any experience with compressed air for painting, neither do I want any, from what I have observed when others were using it. From the apparent results I am fully convinced that no good job of painting can be done with it. Unless brushed after application there is a fluffy or porous condition about it that will not prevent water and air from penetrating, and the result is obvious. As to cleaning steel (for repainting) with compressed air and sand blast, the virtue of the process depends entirely upon conditions. Where air can be easily obtained the sand blast is probably all right to remove light red rust or mill scale, but out on the road where a plant must be set up to remove pits, scales or scabs caused by the action of salt brine drippings, or otherwise, the results obtained do not warrant the expense incurred. To remove these scabs hammers and chisels should be used, for the blow of a hammer will quickly remove them, as they are brittle and very hard, and for this very reason a sand blast will not cut them

away any faster than it will the steel, consequently the structure is weakened somewhat in removing the scabby corrosion with the blast. All of the above conditions are fully discussed at the meetings of the Association of Maintenance of Way Master Painters, and access to the proceedings would furnish more detailed information.

J. S. Rice, Master Painter, L. S. & M. S. Ry.:

1. I construe this to refer to the iron work in roundhouses, shops, etc., and will say that I have never found a paint that will withstand the fumes for any length of time, but consider that red lead is the best I know of. When I say red lead, I mean unadulterated lead and pure linseed oil, properly applied, and the iron work put in proper condition to receive it by removing all scale, grease, dirt, etc.

2. I do not know what the effect would be of salt water on iron or steel which is submerged all of the time, but I do know that where it is submerged a part of the time the effect is very deleterious and there is no paint made to my knowledge that is proof against it.

3. I have had no experience with compressed air for cleaning, but I am of the opinion that work can be better done with it than by any other method, but unless the job is a large one I do not think it economical. On large flat surfaces, I think that painting with air would work well, but on round or flat surfaces of small area there would be too much loss of time and material.

H. Rettinghouse, Chicago & North Western Ry.:

1. My experience has been that graphite or mineral paint does not stand up any considerable length of time under the punishment accorded it when exposed to the fumes resulting from the combustion of coal and coke in locomotives, and while we are continuing the use of mineral paint it is because we have been unable to find anything which is decidedly superior to it. I am glad to see this subject brought up and thoroughly discussed, as it is one of vital importance, and a great many of us are desirous of ascertaining just what really constitutes the best paint under the conditions as set forth.

2. I have never had any experience in regard to the effect of salt water on steel or iron when wholly or partly submerged all or a part of the time. If the subject matter is intended to cover drippings of salt brine from refrigerator cars, then I could say from experience that the action is very detrimental, and I know of no paint that will withstand it.

J. Tuthill, Pere Marquette R. R.:

1. I have found a combination of red lead and graphite the best paint for the preservation of iron and steel. I have had no direct experience with crossings that are badly exposed to fumes from coal and coke smoke from locomotives, but find the above paint gives as good service on the upper members of through bridges as any that we have ever used. Whether it would be entirely satisfactory for the under surface of bridges that have tight floors and come in close proximity to the top of locomotive stacks, I do not know.

2. I have had no experience with steel and iron in salt water, but have noticed some structures built up on iron or steel posts that were in salt water, where the iron was badly corroded, and greatly reduced, in a short time. It seems to me that some protection in the nature of concrete covering, to the extreme height to which these members are exposed, would be beneficial. It is possible that some other material could be applied that would be absolutely weather-proof, less expensive, and more sightly than concrete.

3. We have never used compressed air for painting or cleaning our iron or steel structures.

Chairman of Committee:

There are so many good paints now in use that it would be difficult and unfair to say which we think is best, for the reason that some paints used on our work seem to give good results on some parts of our structures, while on other parts they last but a very short time, either going to dust or scaling. I have yet to find a paint that will last more than three years. The great trouble is that we are all prone to put off until tomorrow that which should be done today; in other words, we do not paint as often as we should.

I find that where iron or steel is left too long a very heavy coat of rust forms and it is impossible to remove it all by hand. The only way in which to clean thoroughly is with the sand blast. After hammering off the heavy coat first, and then cleaning with the sand blast, the paint should be applied before it begins to rust. Very good results can be obtained in this way, yet it is better not to allow a heavy coat of rust to form, by painting at least once in three years. Where cleaned by hand, as we have been obliged to do at the North Station train shed, Boston, which we have just cleaned and painted, and where all the rust could not be thoroughly removed the best paints in the world will not stand; most of the paint which has been on three years is beginning to show the effect of the gases, and in order to save the structure we will be obliged to begin to paint again at once. We have used some thirty different kinds of the best paint in the market.

Mr. Snow in his report has referred to some paints which have given good results. I will add the names of a few more which are standing the test as well as those named: Aluminum Flake Graphite, mixed in oil; June Malleable Gray Copper Ore X Grade; dry red lead mixed with oil by hand; these mentioned for first coat. after which Dixon's Graphite and some others are working well. In my opinion, however, I think pure lead and pure linseed oil if properly mixed will give as good and lasting results as anything that has been found.

In reply to questions 2 and 3, I agree with what Mr. Snow has said in his report.

The above concludes the replies to letters of inquiry, but we beg to append the following articles for your information, although they may not bear directly on the questions which form the basis of this report.

SUPPLEMENTARY REPORT.

George L. Fowler, Consulting Engineer, New York City:

1. From a somewhat extensive experience in this direction, not only in the observation of the action of paint on overhead bridges, but in roundhouses as well, I place a graphite paint at the head of the list.

For the first, shop or inhibitive coats on steel, I am aware that red lead is usually recommended and specified. Personally, I do not feel quite sure that red lead is the best thing to use, even when it is properly applied, because of its oxidizing effects. But, as usually applied, I think that it should be absolutely condemned. Red lead is very heavy and requires constant stirring to keep it in suspension in the oil, so that, as it is ordinarily applied, it runs, is streaky and is laid on in thick patches which do not dry. I have recently inspected some bridge girders that were painted with red lead and which had run and dried in this way. The blotches had skinned over with a wrinkled surface that, when rubbed with the finger, peeled off, disclosing a mass of wet paint beneath. This first coat of red lead is commonly covered with the protective coatings and, as these are laid on, they prevent the drying out of the wet red lead, so that, before long, the paint begins to blister and peel, and the whole purpose of the paint is lost. Personally, therefore, I should prefer to specify that a graphite paint should be used as the shop coat, if for no other reason than that it lends itself readily to a smooth and even laying and will dry with a hard elastic surface free from a tendency to run and therefore smooth, and without soft spots.

So, while I am not yet prepared to condemn red lead as a paint, I feel that its mechanical peculiarities are such as to render it undesirable to use when taken in connection with the class of labor usually employed to lay it.

Now, as to my reason for preferring a graphite paint:

In the first place I have seen it in use in roundhouses and overhead structures for years where it has given the best of satisfaction and shown great wearing qualities. Further than this, during the past year I have made some special investigations that have shown me the reasons for the experience of the past.

It is hardly necessary to call your attention to the fact that inertness is an essential quality of a pigment that is to resist the corrosive actions that are set up in an atmosphere impregnated with acids, as in the case where a paint is subjected to locomotive fumes and that, for absolute inertness, in this regard, graphite is unsurpassed.

It is also superfluous to tell you that a pure graphite paint is not, in itself, well adapted for this work. A pure graphite paint has a too great covering capacity that leaves the coat too thin to be a success when subjected to wear and corrosion. Hence it must be thickened with some other substance, as a pigment, that is equally inert, and such a substance is to be found in silica. The combination of silica and graphite, therefore, makes a pigment that is especially adapted for use where acid fumes are to be encountered. The combination has also an added mechanical advantage in that, while the silica gives a body and texture to the paint, the graphite contributes that smoothness under the brush

that counts for so much by adding to the covering quality and producing that evenness of finish and surface and, at the same time, greatly lessens the labor required in spreading, so that large areas can be covered without undue fatigue.

There is still another reason along these lines. In the course of the investigations referred to, I subjected steel plates that had been coated with a silica graphite paint to a strong acid reaction for several months, without destroying the texture of the surface. To the eye, the surface appeared to be merely dulled, and this dullness, which appeared after a month or so of acid action, did not seem to change thereafter during the whole period of the test. When, however, the surface was examined under the microscope, the reason for this durability was at once apparent.

Ordinarily a paint skin consists of the fine particles of pigment embedded in the dried coating of oil. Each particle should be set in an encysting case of this hardened oil, and the whole outer surface of the freshly-dried coat should be one of the oil. Linseed oil, is not, however, of itself a good resistant to acid action and, when subjected to gases or a bath such as I used, the outer film is soon dissolved and cut away. And it was here that the microscope showed what had taken place and what would have to take place before further deterioration could occur.

The dulling of the surface meant that the outer coating of linseed oil had been dissolved. Then there appeared a surface that, under a magnification of 34 diameters, appeared as though it had been sanded. It was seen to be one covered with a complete coating of the minute particles or grains of silica and graphite, just as a sanded surface appears to the naked eye. In short, the inert silica and graphite formed a complete protective coating to the matrix of linseed oil in which they were embedded; and, until they were worn away or the acid had had a chance to eat slowly in between these particles and so undermine and loosen them, the paint would endure and the surface of the metal beneath be thoroughly protected from attack.

This, then, is the reason for my faith in this class of paint; a faith based both upon a scientific demonstration of its reasonableness and past practical experience.

2. Rust, corrosion, rust! Everyone knows that. Perhaps, however, a detail of some tests that I made may be of interest. I took a number of steel plates and painted them with silica graphite paint and subjected them to salt brine drippings for something more than three months. When the test was stopped, the plates were found to be badly corroded, as was to be expected on the unpainted portions, while the parts protected by the paint showed little or no action of this sort. The unpainted portions of the plates were covered with a thick coating of rust that had swollen and blistered until it projected 1-16 in. or more from the surface of the metal. It could be easily scraped off and, while it was red on the outside, it was black beneath and appeared to be the black oxide of iron. When peeled off it left the metal bright beneath, but it (the metal) turned to a greenish hue within half an hour. As for the painted surfaces, there was no appreciable deterioration except for the loss of the original gloss. I found, then, that here, when subjected to brine drippings, consisting of water in which 20 per cent of its weight in salt was dissolved, the silica graphite paint fully protected the

plates against a corrosion that was of a most serious and destructive character on the unpainted portions of the plate. I may add that one-half of the surface of these plates was painted. The brine was allowed to drip and strike upon the painted part and trickle down over the unpainted portion.

As for the effect of rust on paint efficiency and durability, that is another question of wide scope that need not be discussed here.

3. For painting I understand this to refer to the spraying method and I have found it to be very injurious to the durability of oil paints.

Paint can be laid by this process quite smoothly, but it will not last. The reason is a simple one:

Air always contains more or less moisture in suspension and the warmer the air, the greater the quantity that can be so held. Hence, an atmosphere that may be warm will be perfectly clear, even though the amount of contained moisture may be very high. But, if that air is cooled, clouds and fogs immediately appear because of the precipitation of the moisture.

This is what happens in painting with compressed air. The warm compressed air is usually pretty well saturated with moisture. As it leaves the spraying nozzle, it at once expands and, in so doing, its temperature falls, and some moisture is precipitated. This moisture is, at the time, intimately mingled with the particles of paint and is thus imprisoned in the film that is formed on the surface. The result is moisture in the body of the paint and rapid deterioration.

For cleaning, that is by sand blasting, there is nothing that equals it. In fact, I know of no other way in which a surface can be properly prepared. Wire brushes simply cannot remove the rust and, even if they could, they would leave the surface so covered with a fine dust, that any paint laid over it would have the elements of its own destruction embedded in it. But the residue of rust is the principal evil to be guarded against. For example: In some of my investigations I had subjected a paint to an action for several months without apparent injury other than a dulling of the surface gloss. It appeared to the eye to be in proper condition for repainting. Before doing this, however, I examined it under the microscope and found it to be totally unsuited for repainting. I found that minute blisters had arisen on the surface and that many of these had burst, leaving a small crater-like hole in the center. This hole was about 1-2000 in. in diameter, but down in the bottom of it I could see the red rust that had formed on the bared metal. If, then, the plate had been repainted, there would have been a rapid deterioration of the surface and for no apparent reason. You can see, then, that this serves as an explanation why it so frequently happens that the repainting of a structure with the same paint originally used is so unsatisfactory while the original painting was all that could be desired. Scraping and using a wire brush cannot get at these microbes of deterioration, as they may be called, and I know of nothing but sand-blasting with compressed air that will.

From the Boston Transcript:

Electro-chemical Theory of Rust.

In bulletin No. 35 of the Department of Agriculture, just issued, Allerton S. Cushman gives results and conclusions from investigations made by him of the cause and prevention of rust. The fundamental theory advanced is that steel corrosion is the result of electro-chemical action. Accepting this theory, the author investigated the effectiveness of various coatings in preventing rust. About fifty substances were tested, and of these zinc, barium and lead chromates made the best showing, while lampblack and graphite seemed to stimulate rather than inhibit rust. (Durability was not considered, and the conclusions apply to priming coats only.) Varnish and bitumen showed up especially well. The author believes that concrete prevents corrosion because it contains free lime, and if this is washed out rusting becomes probable. Steel immersed in soggy, sour clay can have its life prolonged by the addition to the clay of five per cent of quick lime. Perfectly homogeneous steel, as free as possible from segregation, will resist rust without a protective coating, it being probable that open hearth steel can be made to meet this description.

The Gazette, Montreal, June 11, 1909:

A new development in protecting trestles was foreshadowed at the sittings of the railroad commission at Ottawa this week, when engineers stated that the Canadian Pacific was experimenting with a fireproof paint for wooden trestles and bridges. It was stated that a trestle treated with this fireproof paint had been subjected to a pretty severe test, and met it with promising results. An engine was run slowly over the painted trestle and as it went the ashes were shaken out in such a way as to allow every chance for a fire. Later, the engine was brought to a standstill at the center of the trestle and red hot cinders shaken out of the fire box in a heap on the painted ties. The first ashes from the moving engine made no sign of fire, while the heap from the standing engine caused a slight blaze on the ties, which went out in a few minutes without causing any damage. The results of the experiments were decidedly satisfactory, and further work will be done to demonstrate the usefulness of this fireproof paint. If it proves a success, it will probably be adopted on all wooden trestles and bridges along the Canadian Pacific Railway, especially on those located on remote sections of the line, where most trouble is caused by fires. (This refers to Clapp's fire resisting paint, Bridgeport, Conn.)

From Hammond, Boynton Paint and Chemical Co.:

In this era of great sky-scrapers the question of the adequate protection of the steel structures is one that can not lightly be set aside. For centuries the oxide paints have been in use for protecting steel, and there are examples even in this country today of the perfect protection of metal by good oxide paints of over a hundred years' duration. Our Ferox Protective Paint is pure, of great elasticity, non-conductive and unaffected by deleterious gases and affords the maximum protection to iron and steel. The reasons briefly: The pigment is pure, spongy in character, absolutely

anhydrous and ground to extreme fineness. The linseed oil is the best. The Ferox is standard in quality and price; only one Ferox paint being made, and that the best. We shall be glad to go into the technology of Ferox of the practical tests which have been made with it if you desire.

Paper by G. B. Heckel, of the New Jersey Zinc Co., read before the annual meeting of the American Society for Testing Materials, Atlantic City, N. J., July 1-3, 1909:

Of the materials found to be inhibitive of corrosion, the soluble chromates stand very high, steel having been found to be practically uncorrodible in a solution of these salts. This fact led to investigation of the chrome pigments, and it was found that these, excepting a few in which an acid reaction is maintained, are all similarly inhibitive—zinc chrome most conspicuously so. Zinc oxide and zinc lead white also rank high, white lead moderately high, red lead still lower, etc.

On the other hand a large number of commonly employed pigments appear to be either neutral or indeterminate, while still others, as was anticipated, seem to be more or less powerful stimulants of corrosion. Out of this mass of tentatively accepted facts has developed a provisional theory along which the more advanced manufacturers are now engaged in working out a new mode of procedure in the painting of steel.

The theory is that rust-stimulating pigments should never be placed in contact with the steel surface, but that an inhibiting priming coat should always intervene. This inhibitive coating may be suitably compounded of the chromes, zinc oxide, white lead, red lead, willow charcoal, etc., among the inhibitors, or of any of the neutral or indeterminate pigments, reinforced with a small proportion of the stronger inhibitors, such as zinc chrome, zinc oxide, zinc and lead chrome, etc. Over this priming coat the air and moisture-excluding coats can then be safely applied; these coats being designed for protection only, without regard to inhibitive qualities.

The Bureau of Promotion and Development of the Paint Manufacturers' Association, in conjunction with Committees E and U of the American Society for Testing Materials, is now engaged in a series of exhaustive field tests at Ventnor, near Atlantic City, with a view to further development of these theories in actual practice.

A. B. HUBBARD,
R. P. MILLS,
H. E. HOLMES.
G. ALDRICH,
Committee.

DISCUSSION.

Mr. Hubbard.—Some paints I find are used in some localities with good results and not so good in other localities. We have experimented with several different kinds of paint, as you will see from the report, and are now await-

ing results. I examined them before coming to the meeting, and some of them that were the most strongly recommended we found had gone almost entirely to dust. Some others I found which had not come with any recommendations, except from their manufacturers, have given good results.

Mr. Sheldon.—All I can say is that we are seekers of knowledge on this matter.

Mr. Richey.—I am free to confess that I do not know anything about the question of securing a good paint, that will give us the results we are after.

Mr. Killam.—I have had a good deal to do with the matter of painting on our road, by recommending when painting should be done and keeping record of everything, but the conditions on our line vary so much that we have some structures that we are obliged to paint every three years, while at other places the same paint applied by the same workmen will last up to fourteen years and be in better condition. We have a standard paint which we have been using for years, and when we have an application to try other paints we paint a piece of steel with the sample submitted and hang it out over the edge of a bridge on our system about twelve feet above salt water. Every plate is marked, and a record of it is kept in our office, and once or more each year I examine these plates and make a record of the condition of the paint. At the present time we are testing 27 different samples of paint. Last year I took the record and there was one that was in good condition, two that were fairly good, three that would last another year and the rest were all gone. Probably many of these paints that were gone if applied in a dry section of the country would last much longer.

We use what is known as the Walter Carson paint, manufactured in England. It is used on the English battle ships. We also use another paint that is manufactured by a firm in Birmingham, England. The Carson paint will last longer than the other, but they are both good paints. Furthermore, in giving orders for painting we specify what

kind of paint shall be used. We do not allow contractors tc select any paint other than those named in the specifications. I find that there is no branch of maintenance work that must be looked after so carefully as the painting of bridges along the line, and the selection of a good paint is one of its most important features.

I may say that in the mixing of our paints we do not allow any boiled oil to be used; nothing but the pure raw oil, and the second coat must not be put on during the next 48 hours or during damp or foggy weather or when there is frost on the ground. It may be done in the winter, but not when there is any dampness in the air. In that way we get about as good results as are possible.

Mr. Clark.—I would like to ask Mr. Killam whether he mixes his own paints or buys a certain brand of paint.

Mr. Killam.—We buy the dry powder from the English firms, as mentioned, and then put in the raw oil. We are protected on these purchases by rigid English statutes covering exports and by equally rigid Canadian statutes covering imports.

Mr. Pickering.—I would like to tell you of a little experience that I had this summer. I was notified to go and see a set of buildings in a village that I am credibly informed were painted some fifteen years ago and which have not been painted since. Immediately adjoining them are other buildings that have been painted three times with white lead and oil and which are not now in as good condition as the set of buildings painted fourteen years ago. I have the formula of the paint that was used and have mixed up some of it, and am now having my house painted with it, and am investigating it for the railroad as well. I know I will surprise you all when I tell you the price, which is fifteen cents per gallon. As I stated, I have the formula and I will report results later on.

Mr. Strouse.—Mr. Sheldon has expressed my views on the subject of paint very thoroughly. There are some points of the Washington structure that are already badly in need of repainting after but two years' service, and on

the steel trusses where we used the Chrysallite paint they required repainting in about one year's time. I feel that there is a great deal to be learned on the subject of paint, and that I know very little about it.

Mr. Clark.—I would like to ask if any member has found a paint that will withstand the effects of dripping salt water on our iron bridges. The loss is quite an item.

Mr. Killam.—We have not been troubled much by salt water drip, as we have very little leakage from our cars, but we do have trouble at one of our transfer bridges where the draw lifts up and down into the salt water about ten times a day and then dries off. We have to paint that every two years, and it costs us from $650 to $700. The paint is in bad condition after two years' service, but not so much that it affects the steel to any extent.

Mr. Storck.—If any one has a paint that withstands gases I would like to know of it. I have tried since last year about eighty different kinds of paints on test plates, and, so far, I have not discovered one that will last six months.

Mr. Killam.—I have a bridge exposed to such conditions that has been painted for the last five years and in going over the rods and trusses we find the paint in good condition yet.

Mr. O'Neill.—Has any one discovered a paint that will stay for any length of time on galvanized iron? I have not been able to find any. We have some downspouts at a station that we are not able to keep looking well.

Mr. Andrews.—There are a number of paints on the market which claim to be good for galvanized iron, but personally I have not been able to find any which come up to the claims. A first coat of red lead and a finishing coat of whatever you wish to use is about the only thing that will stand up very long. It will last longer than six months in any event, and sometimes two years, and I believe it is the proper thing to use. There is one thing that I would like to say and that is, do not try to buy a dollar paint for forty cents. (Laughter and applause). If you want a good paint, go to a reputable manufacturer and say to him: "We want you to make us

the best paint that you can; a paint that you can guarantee as a good paint for a steel structure; a paint that you feel you can give us without injury to your reputation as a manufacturer, and we are willing to pay you a price which will cover the cost of first-class material and still leave you a profit." Then, I believe you will get a good paint, but you will not if you try to pay forty cents for a paint that costs 80 cents to produce. Most of you know what amount of material it takes to make a gallon of paint, and its approximate cost, to which there must be added the cost of the labor in grinding and mixing, and on that, as most paint is sold f. o. b. your town, there is still to be added the freight. I say give the manufacturer a fair price for good paint. (Applause).

Mr. Hubbard.—On galvanized iron I tried a paint two years ago which is called Galveno, and which costs $1.50 per gallon. We put on only one coat. I believe it to be a good paint for this purpose.

Mr. Andrews.—I think it is a fairly good paint for galvanized iron work, but not so good as red lead.

Mr. Fake.—I wish to say that I have painted galvanized iron to a large extent and have no trouble with it peeling off.

Mr. Clark.—I have galvanized iron painted with red lead and oil twelve years ago and while it is slightly discolored you can see the red lead still there doing business, just as it did twelve years ago.

Mr. Killam.—With regard to that part of the subject dealing with painting by the use of compressed air, I may say that I have had some experience. I was always opposed to this method because many of the small members of a bridge cannot be reached by it, but our engineer of maintenance concluded to buy a gasoline engine and sprayer, which cost us $1200, and they tried it on a large bridge. They finally got it done but had to resort to the brush to paint the small members. We are now using the gasoline engine for other purposes and this method was not tried again.

XIII.

COALING STATIONS AND CINDER PITS.

REPORT OF COMMITTEE.

To the American Railway Bridge and Building Association:

The committee has found such a multiplicity of types of structures in use, that the limits of this paper will not permit of anything like an exhaustive discussion of them. Add to this the numerous modifications of the various types and the lack of definite information is the committee's apology for the incompleteness of the report.

While the committee recognizes the intimate relation existing between coaling stations and cinder pits in the economic operation of railways, we feel that the whole subject covers too much ground for one report. The committee therefore recommends that for future reports the subject be divided into its two component parts.

The importance of economical handling of coal is a matter that deserves a good deal of attention. The railroads of this country consume about 115,000,000 tons of coal per annum. A saving of one cent per ton would amount to $1,150,000. This is equivalent to about $6 or $6.50 per mile of railroad.

COALING STATIONS.

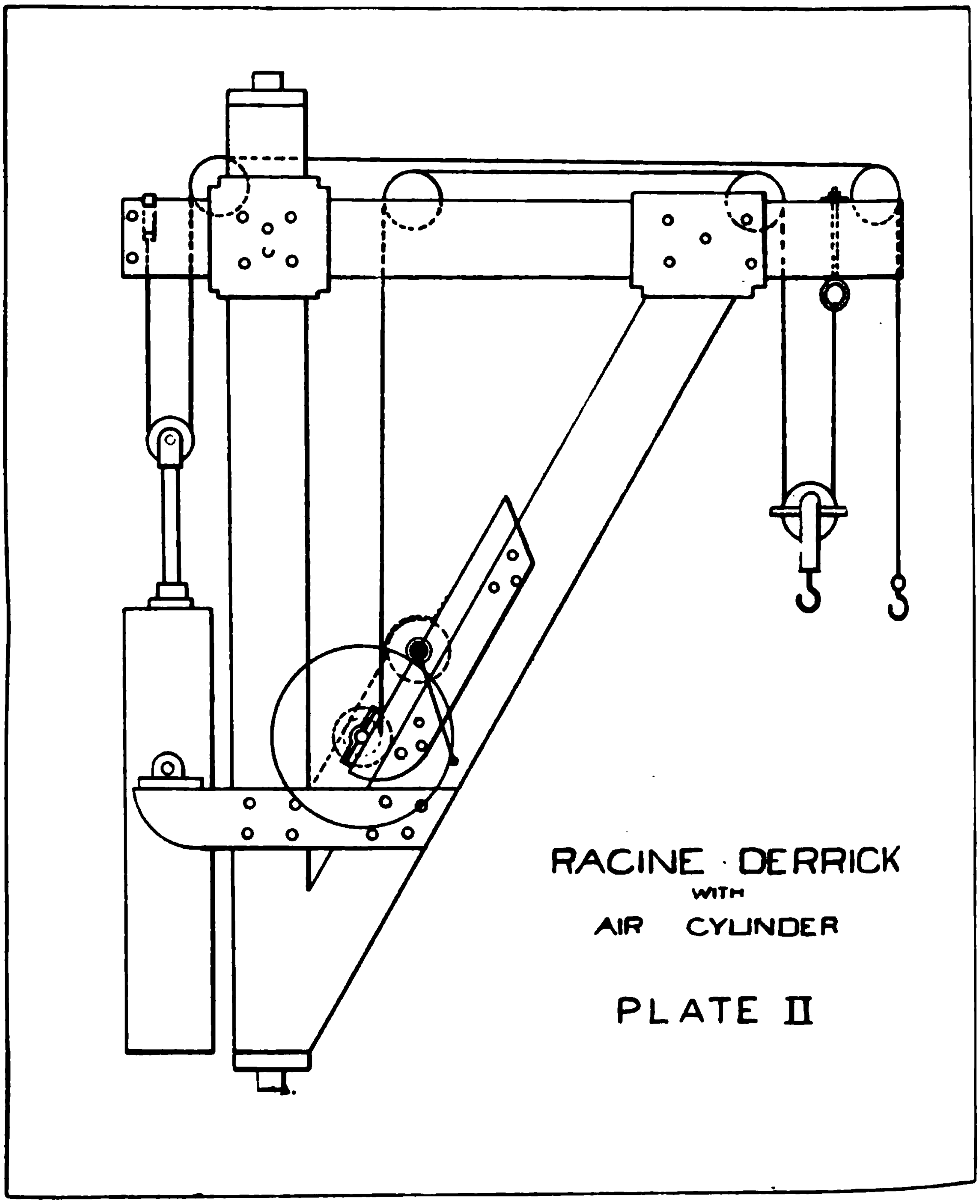
The subject of coaling stations will be presented under the five following general heads:

1. Derrick Coaling Stations.
2. Chute Coaling Stations.
3. Clam Shell.
4. Mechanical.
5. Miscellaneous.

One of the most common types of derrick coaling stations is shown on Plate 1. The derrick is shown more in detail on Plate 2.

Where the amount of coal consumed per month is small this method of handling the same has proven quite satisfactory. The coal is first shoveled from cars into the shed, and from there into buckets as it is wanted. These buckets are transported from the shed to the derrick on the small car shown on Plate 1. The buckets are hoisted to platforms "A" or "B" by means of a derrick operated by a winch, as shown on Plate 1. In most cases on the Chicago, Milwaukee & St. Paul Railway this winch is placed on the brace and not on the mast of the derrick. On the mast an air cylinder is fitted for hoisting the buckets. Where air is used platforms "A" and "B" are omitted, and the coal is hoisted from the level of the loading floor. The air for operating the derricks is taken from the locomotive that is being coaled.

Derrick Type Coaling Station for Loading from Storage Bins to Locomotives.

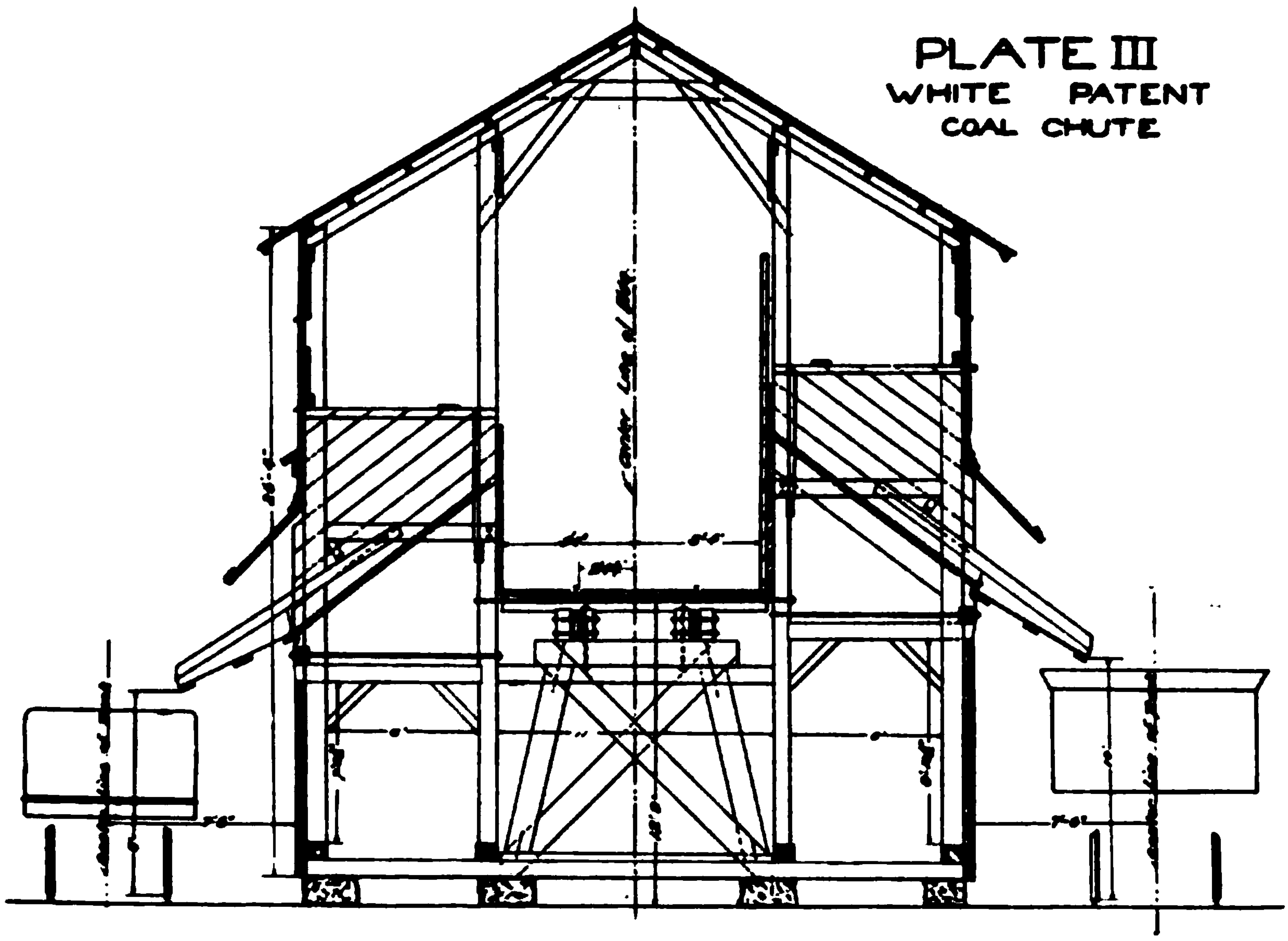


Coaling Derrick for Hand or Air Power.

At some of the stations provision is made for shoveling direct from the car to the buckets. These buckets hold ½ ton. In some cases it is found economical to shovel direct from the cars to the tender.

Where the amount of coal used is quite small the handling is usually done by the regular section forces. In most cases, however, one or two additional men are required.

Under the head of "chute" coaling stations we find a great variety of structures. The chute known as the "White" patent is the most common, especially on western roads. The general



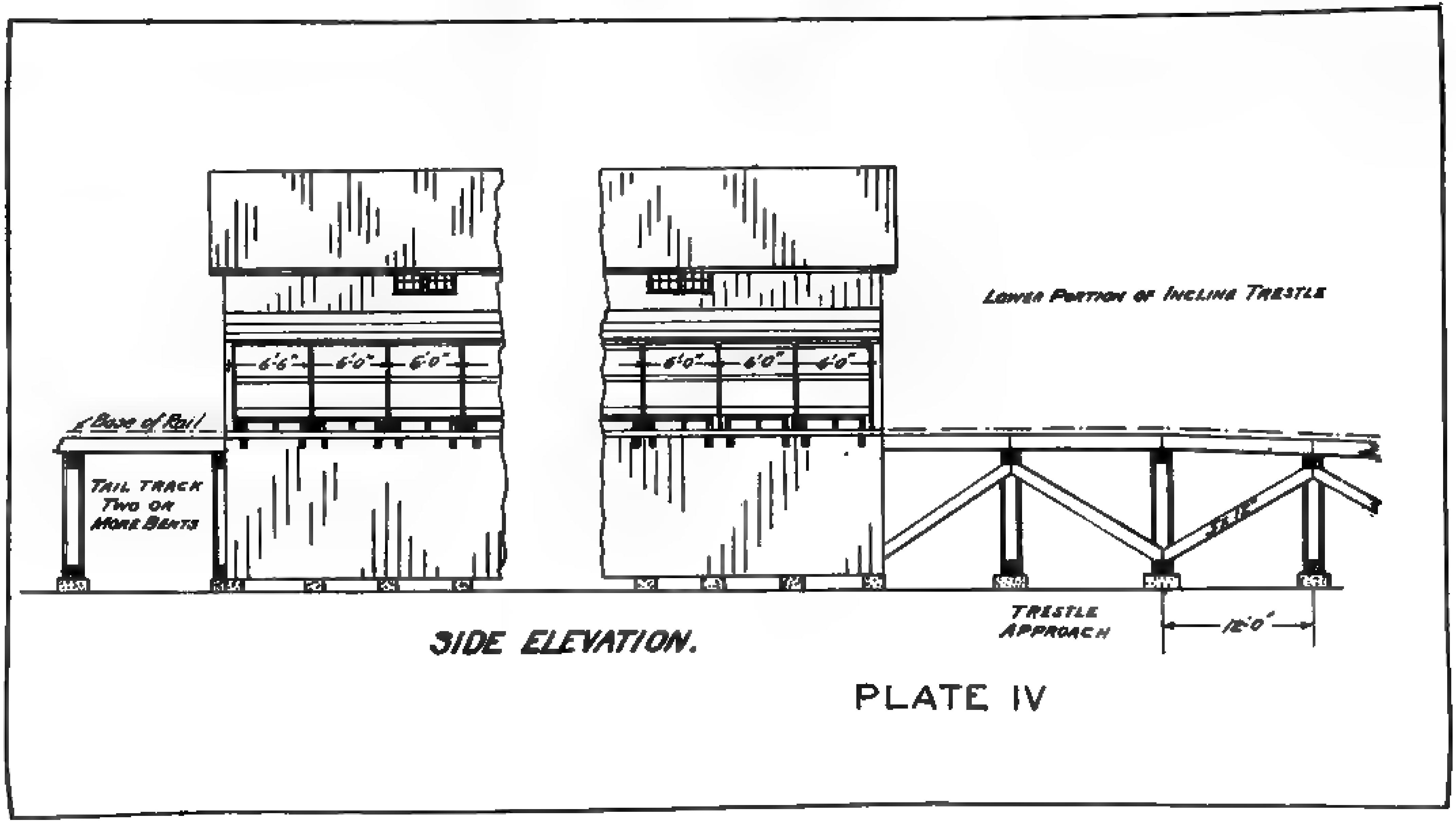
White Patent Coal Chute

construction of this chute is shown on Plates 3 and 4. The chutes may be on one or both sides of the shed, depending on local conditions.

In most cases cars of coal are delivered to the plant by means of an incline and a locomotive. In some instances, however, a short. steep incline is constructed and the cars are hauled up by means of a stationary engine and cable. The coal is then shoveled into the chutes. When a locomotive takes coal the fireman or hostler opens the chute by means of a chain.

As a general rule, in coaling stations of this character a regular force of coal heavers is employed, the number of men, of course. depending on the quantity of coal handled. On account of the easy adaptability to local conditions this style of plant is in high favor, whether for handling large or small quantities of coal. Mr. Gagnon of the Minneapolis & St. Louis Railway, reports this as being the most satisfactory type of coaling plant in use on that road. On the C., M. & St. P. Ry. it has been used extensively in the past, but is now being supplanted to considerable extent by numerous mechanical varieties.

There are, however, some serious objections to this type of coaling station in congested terminals. The large amount of room occupied is objectionable. Real estate is often high priced, and hence is usually wanted for other purposes. The item of maintenance is another objection. This is an all-wood structure and the high price of timber, considering the large amount used, makes the maintenance item a large one.



White Patent Individual Pocket Chute with Incline Trestle.

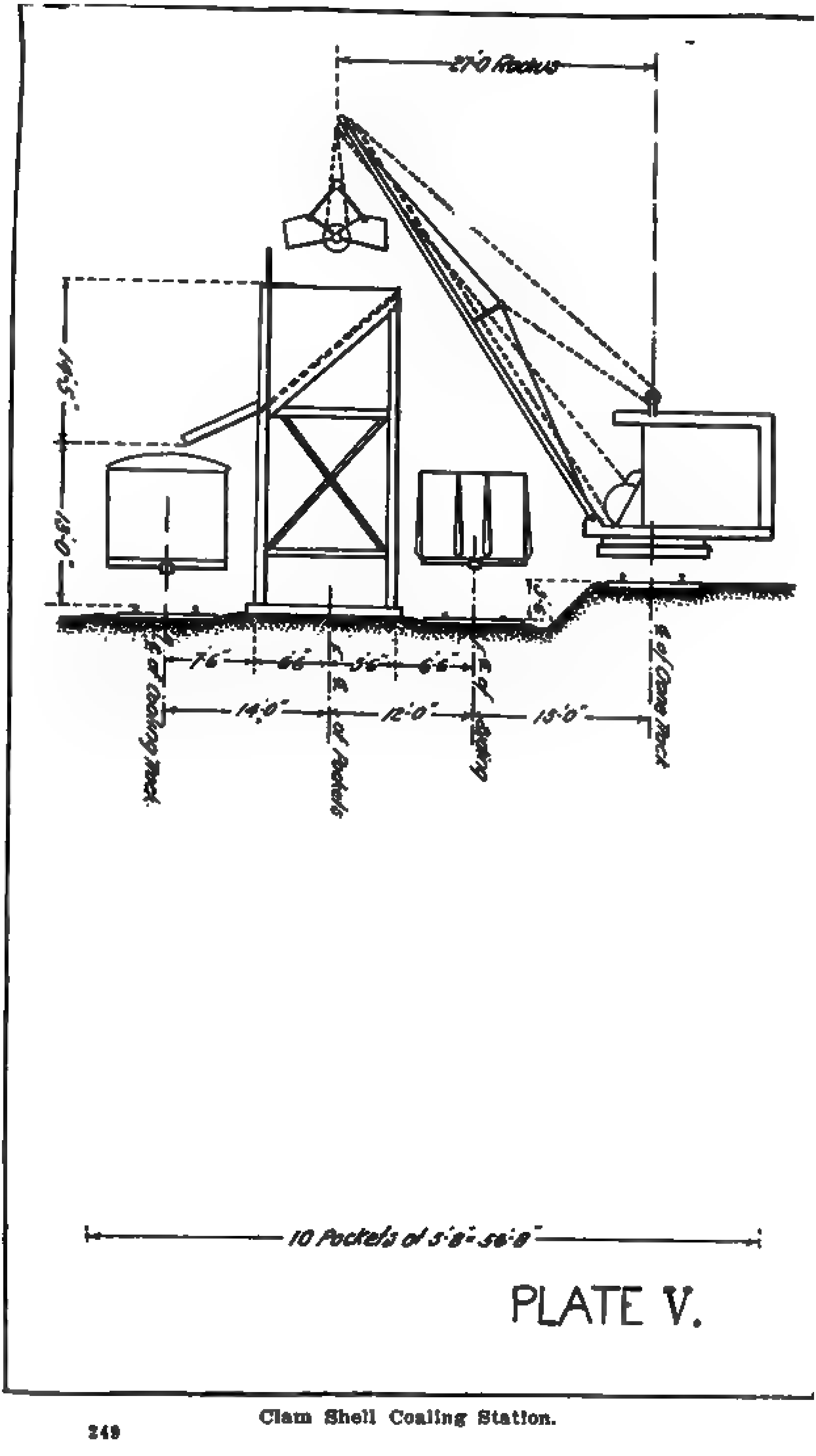


PLATE V.

Clam Shell Coaling Station.

A six-pocket chute with 500 feet of trestle costs from $5,000 to $7,000. The cost of maintenance for the first ten years is very small. After that the charges will average about 10 per cent of the first cost per annum.

Under the third heading, that of clam shells or steam shovels, we have a type not as common as the previous one, but one, nevertheless, that is in use on some of the large roads. The general features of this plant are a suitable tract of land, about on a level, or a little below the adjoining tracks. The ground is covered with tracks at suitable distances apart, to accommodate the reach of the clam shell, which is self propelling. The coal is usually unloaded from the cars with the clam shell and piled as high as conditions will permit. The locomotives to be coaled are spotted on the adjoining tracks, or on the tracks leading under the coal.

The expense of handling coal by this method is quite economical, but there are some serious objections. The space occupied is in a great many cases, prohibitive. Another objection is the danger of spontaneous combustion. Also the coal exposed to the weather for considerable length of time deteriorates in value. On the other hand, with a plant of this kind there is the advantage of having a large quantity of coal in storage. This is an important safeguard against shortage due to strikes and other incidents in railroad operation. A plant of this character is in operation by the Illinois Central Railroad at Dubuque, Iowa.

Another variety of the clam shell type is shown on Plate 5. This is one of the types used on the Intercolonial Ry. In this case the clam shell is operated by a locomotive crane and conveys the coal from the cars to the chutes. Hence, it is a combination of Classes 2 and 3. In come cases the clam shell is used to convey the coal direct from the cars to the tender. In any case where a locomotive crane is used for handling coal economy would require that there be other available work for the crane when not so employed.

MECHANICAL COALING STATIONS.

In considering the mechanical coaling plants we take up a subject concerning which there is considerable diversity of opinion. There are a number of these patented devices on the market. The general features of most of these are:

1. The dumping of coal from self-cleaning cars onto a breaking device. The unloading floors of these plants are usually on a level with the surrounding yard, or a little above.

2. The hoisting of the crushed coal from below the track to a storage bin some distance above the track.

3. The drawing of the coal from the storage bin into chutes for delivery to locomotives.

4. The weighing of the coal.

Modifications of these general features occur in most of these patented devices. The breaking devices are either breaking bars or mechanical breakers. In order to avoid the necessity of always employing self-cleaning cars, provision should be made at these plants for unloading by hand, as emergencies frequently arise where self-cleaning cars are not available.

In discharging coal from self-cleaning cars it is sometimes dumped upon breaker bars, where it is broken to the required size by hand

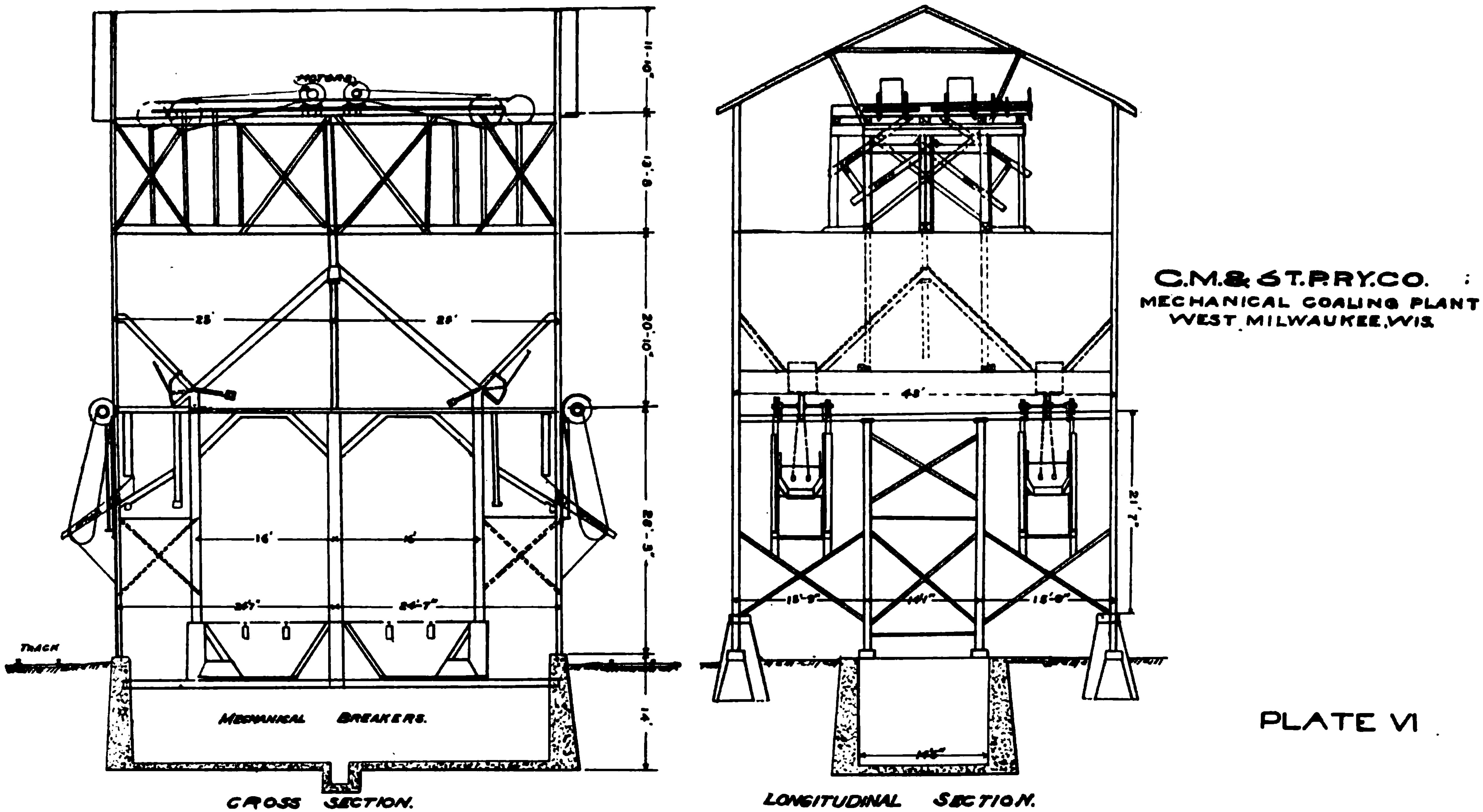


PLATE VI

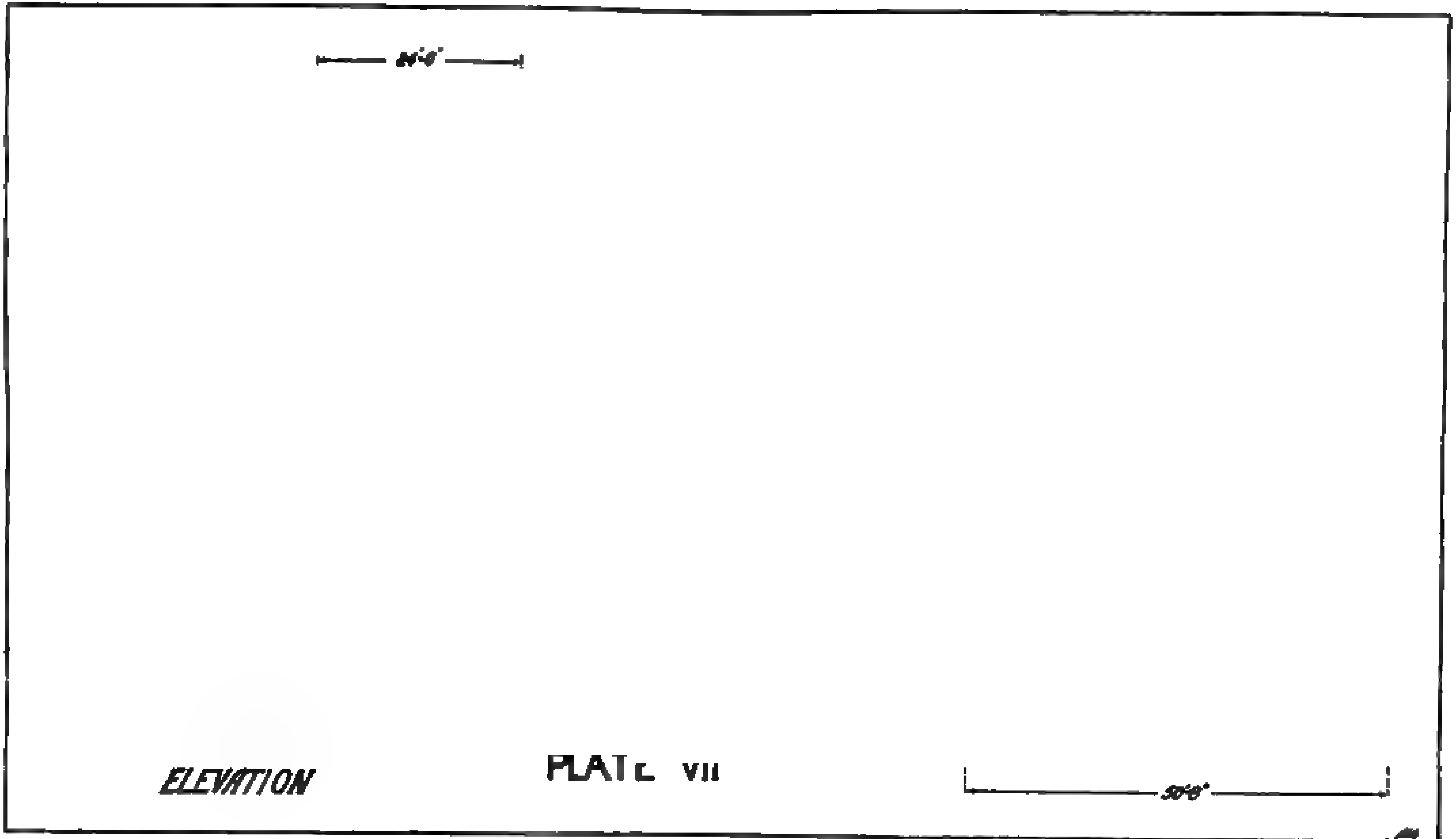
Mechanical Coaling Plant, C., M. & St. P. Ry.

power. Most of the larger plants, however, are provided with mechanical breakers placed below the tracks. In either case, after the coal is broken it falls upon a conveyor which transports it to the elevator. This elevator carries the coal by means of buckets to the storage bin in the upper part of the building. Plate 6 shows the general features of one of these mechanical plants. Another variety of this type of coaling plant is shown on plate 7. This, as will be noticed, is a plant of much larger capacity. On the C., M. & St. P. Ry. there are several varieties of mechanical plants in use. There are some manufactured by Fairbanks, Morse & Company; others by the Link Belt Company; and still others in which the machinery has been purchased from various parties and assembled by the employees of the railway company. The committee has been advised that these plants have all proven satisfactory; some, however, to a greater degree than others.

In addition to the above types of coaling stations there is an endless variety of plants with their various modifications in use on almost every railroad in the country. In a great many cases there are local conditions which make a special type decidedly economical. One of these types is commonly used where there is a piece of high ground adjacent to a terminal and considerable coal is consumed, the high ground being used for storing large quantities of coal. This coal is unloaded either by hand or by clam shell. At right angles to the track, used by the locomotives when coaling, are a number of tracks for operating coal tipples. These coal tipples are loaded with coal at the storage pile and are then run to the edge of the embankment and discharged into the tender of the locomotive as required.

Another type used to some extent is where the coal cars are hauled up an incline bv means of a gasoline engine and cable. The coal is then shoveled from the cars to small dump cars. From the rear end of the incline there is a bridge across the main tracks, above which there is a hopper for receiving the coal. The small dump cars are run out on the bridge and discharge their load into the hopper. This type of station is generally used for coaling freight trains between terminals. In other words it is merely a supply station for coaling locomotives while in transit with their trains.

In considering the type of coaling station to be used at any one point a good many elements enter. The question of ground room is, in a great many cases, an important consideration. This is especially true around busy terminals. The first cost of the plant must also be taken into account, together with the relative expense of operation and maintenance. It is also necessary to consider which type of plant will meet the requirements of traffic at each particular point. Another very important feature is the character of the cars that are available for handling the coal. For instance: A mechanical coaling plant requiring self-cleaning cars would be a very expensive affair where traffic was such that the cars would be hauled from the coaling station to the mines, or any other distant point before receiving cargoes. In this connection it should also be borne in mind that the handling of coal loaded into box or stock cars is not only more expensive than when it is loaded in gondola cars, but the coal contains more slate than when loaded in gondolas. This is due to the fact that the slate pickers at the mines have not the opportunity to remove the slate. Box and stock



Mechanical Coaling Station.

cars are also much more liable to have an end knocked out than are gondolas. This damage to the ends of the cars is in most cases due to the force with which the coal is discharged from the mechanical loader at the mines. This is particularly true where the loader handles 1,000 or more tons per day.

It will be evident to anyone who has given the subject consideration, that it is out of the question to recommend any particular type of plant for general use. A plant that would be economical at one point might prove very expensive at another. There seems, however, to be a tendency to employ apparatus requiring a minimum number of men to handle it. This is not only true of the mechanical plants, in general, but applies equally well to all coaling stations. One great advantage in this is the lessening of danger from labor troubles, either strikes or shortage of help. Usually, however, the prime consideration is the decrease of fixed charges. The entire subject resolves itself into the question of what is the most economical plant to meet the conditions at any particular point. The committee has endeavored to call attention to some of the elements that should be considered in answering this question.

While it is not possible to fix the limits between which various types of coaling plants should be used, there are some general recommendations that can be made:

1. At terminals where the amount of coal used is small and time permits, the engines can be coaled by shoveling direct from the cars to the tenders.

2. Where the amount of coal handled does not exceed 100 tons per day a derrick and bucket plant seems advisable. If, however, the conditions are such that there is other work for a locomotive crane to do, that is frequently more desirable.

3. Where the amount of coal handled per day varies from 100 to 250 tons a clam shell and chute seems desirable, provided there is other work available for the clam shell.

4. Where more than 250 tons are used per day a trestle incline and chutes, or a mechanical plant, is probably the most desirable, the choice depending largely on local conditions.

Aside from the type of plant employed the character of the structure should have consideration. Reinforced concrete costs about 40 per cent more than heavy timber construction. The insurance charges are about four times as great for timber as for reinforced concrete. This difference in insurance amounts to about 15 per cent of the first cost of construction, leaving a difference of 25 per cent in favor of wood. There is, however, less liability of interruption to traffic from fire where fireproof materials are used. The cost of maintenance is materially reduced. It would, therefore, seem advisable to use fireproof structures where the volume of coal handled is very large. The question of adequate fire protection is certainly deserving of attention. Another important consideration, especially at mechanical coaling plants, is the quantity of coal slack resulting from the breaking of the coal.

Owing to different methods of accounting on different roads, the cost of handling is not a reliable guide in comparing the relative merits of various plants. Each station, with its local conditions, is a problem in itself. It should, therefore, be borne in mind that what is presented here is only a general guide. In making comparisons the cost item should include interest and depreciation.

maintenance and operation, and a charge for cars used for storage purposes.

The following is a statement of such costs of handling coal as the committee was able to obtain, these data including the cost of operation only: For coaling stations of the derrick type 11½ cents per ton. The amount of coal handled at the plants from which these figures were obtained varies from 10 tons to 100 tons per day.

At chute coaling stations of the White patent type the expense is 4½ cents per ton; at the mechanical types of various makes 1½ cents to 3 cents per ton. These figures are true only of the particular stations investigated. Other plants in other localities might materially modify the figures.

REFERENCES.

Reference is made to the article on Auxiliary Coaling Stations, Page 78 of the Twelfth Proceedings.

The subject of Modern Coaling Stations and Cinder Pits also appears in the Sixteenth Proceedings on Page 101.

CINDER PITS.

The economical handling of cinders and clinkers from locomotives is a subject well worthy of serious consideration. While it is not nearly so difficult a problem as that of handling coal, it nevertheless possesses some points of interest.

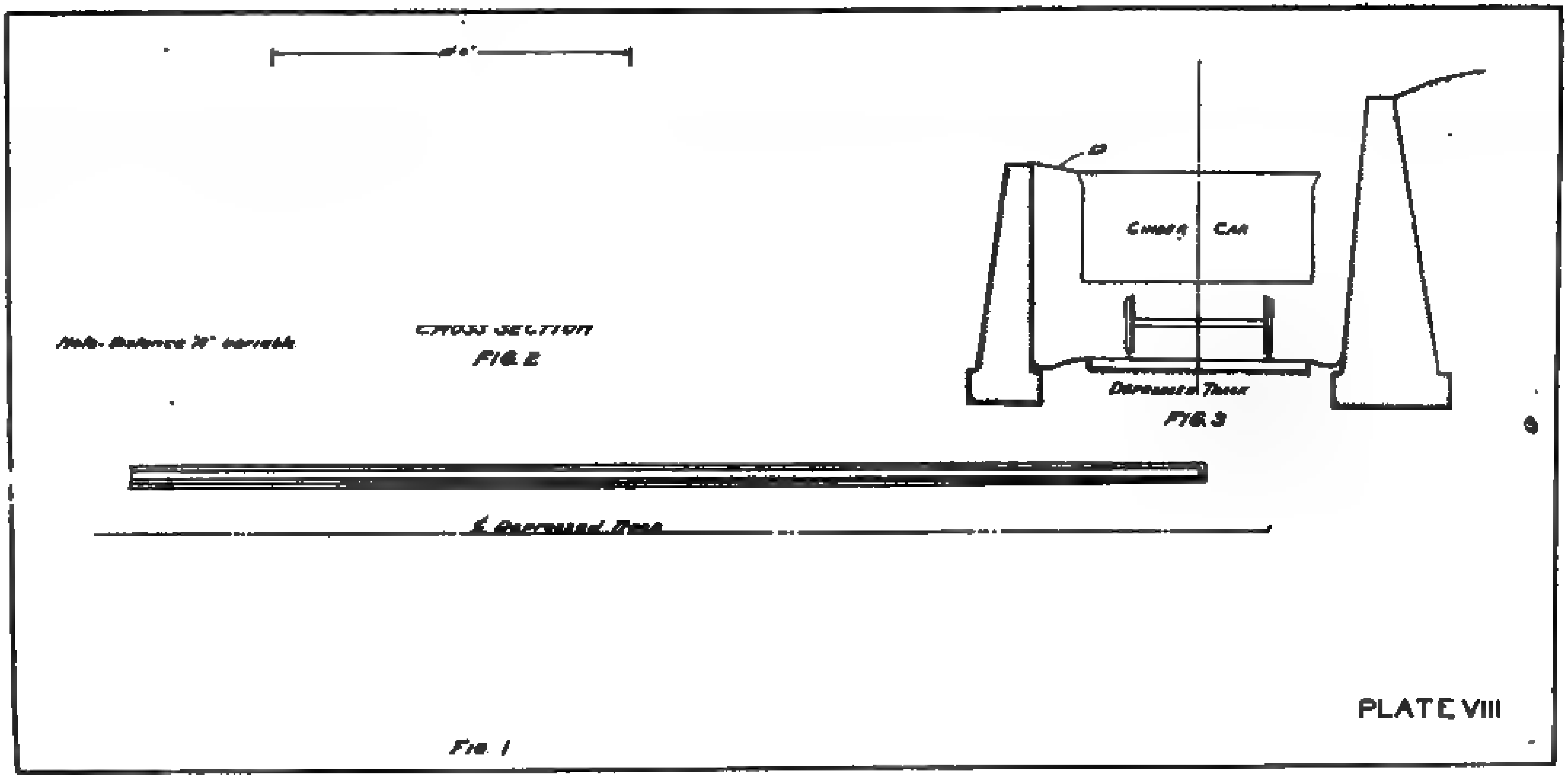
There seems to be an almost universal adherence to the open side pit operated by hand. While there are some modifications of this type of pit, the distinctive features are for the most part retained. This pit is shown on Plate 8. Some of the principal variations in this kind of pit are:

1. The variation of the distance "A" (Fig. 2, Plate 8).
2. Frequently one rail of the engine track is carried on top of wall "B."
3. Variation in the character of the support "C" for engine track.

The distance "A" usually varies from about 2 ft. to 8 ft. Where drainage can be obtained for the depressed track, and the volume of cinders warrants the cost, it seems advisable to depress the track so as to bring tops of high gondolas slightly below the level of the shoveling floor. In this case an iron apron, "D," can be used to good advantage. Its use materially facilitates the handling of cinders, and also keeps the depressed track reasonably clean. Unfortunately, this arrangement can be used in comparatively few places, as usually adequate drainage can only be secured at prohibitive cost. The incline for the depressed track also takes up considerable room.

Plate 9 shows a type of pit used on main tracks for handling cinders between terminals, or at terminals where the amount of cinders is small. While this type of pit is a very good arrangement for such conditions, it cannot be used to advantage at a busy terminal. Owing to the usual location of these pits, it is generally necessary to keep them covered when not in use. For this purpose grates constructed from old engine flues make a satisfactory and economical covering.

Plate 10 shows a pneumatic cinder conveyor. In this case the track on which the cars are placed for receiving the cinders is on the same level with the engine track. The cinders from the engines



General Plan for Cinder Pit and Depressed Track.

PLAN

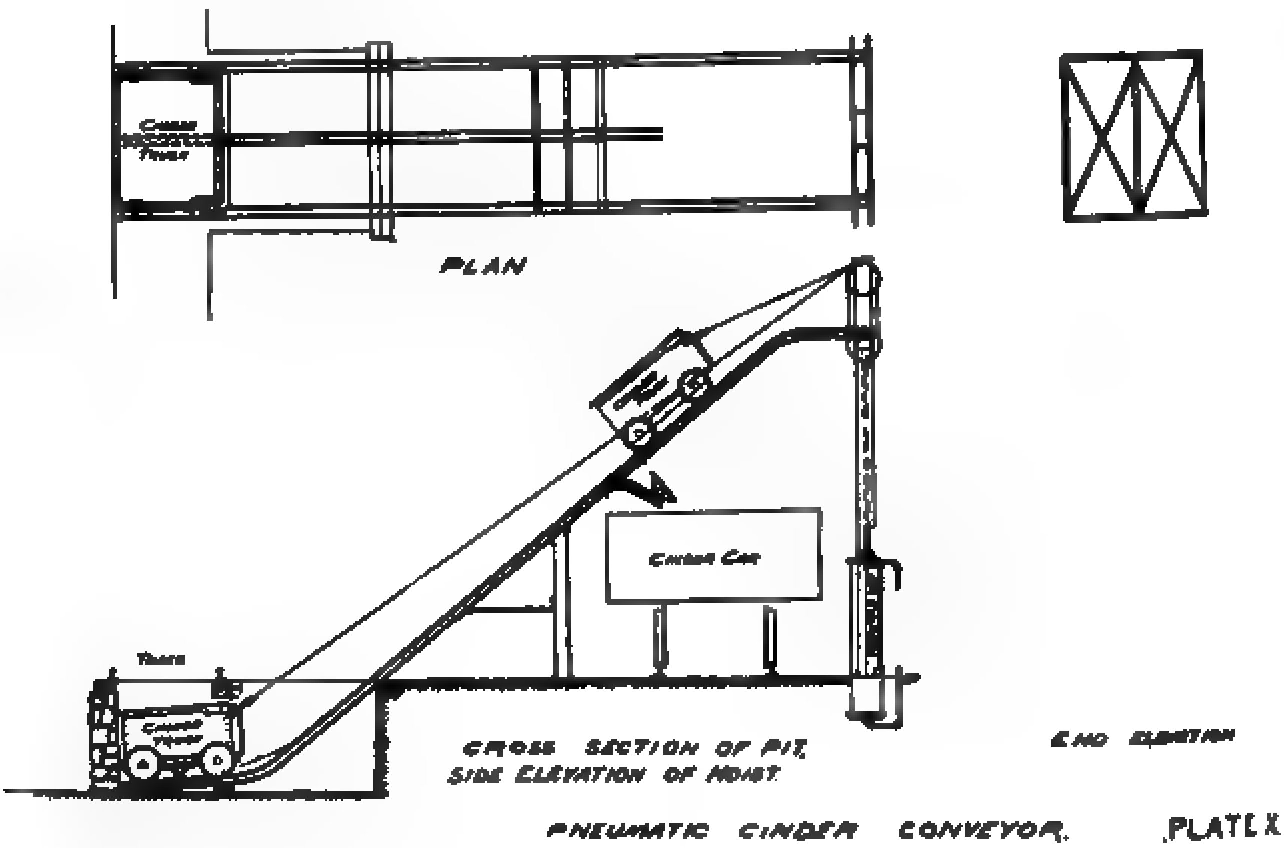
CROSS SECTION

PLATE IX

Cinder Pit for Cleaning Engine Fires on Main Tracks, C., M. & St. P. Ry.
(Usually Covered with Grating.)

are dumped into the iron car below the track. This car is then hauled up the incline by compressed air and automatically dumps the cinders into a gondola or a cinder dump. This incline is made of ordinary T rails. The character of the whole construction is such that the maintenance cost is very low. In addition to this the drainage problem is easily solved owing to the shallowness of the pit under the engine track.

A device of this kind can be used only when power is available for its operation. While Plate 10 shows a conveyor operated by air, there is no reason why other motive power could not be employed. This is a patented device and probably the manufacturers furnish them with any motive power desired.



Pneumatic Cinder Conveyor.

The following table gives the results of a 14-day test of the economical value of this apparatus as compared with an open side pit:

	Pneumatic Conveyor	Open Side Pit	Total
Switch engines,	3	424	427
8 wheel simple engines,	357	85	442
10 wheel simple and larger,	716	56	772
Total,	1,076	565	1641
Average per day, 14 days,	76.9	40.4	117.2
Number of men employed,	12	4	16
Wages per day,	$22.27	$7.44	$29.71
Cost per engine (wages),	.29	.184	.254

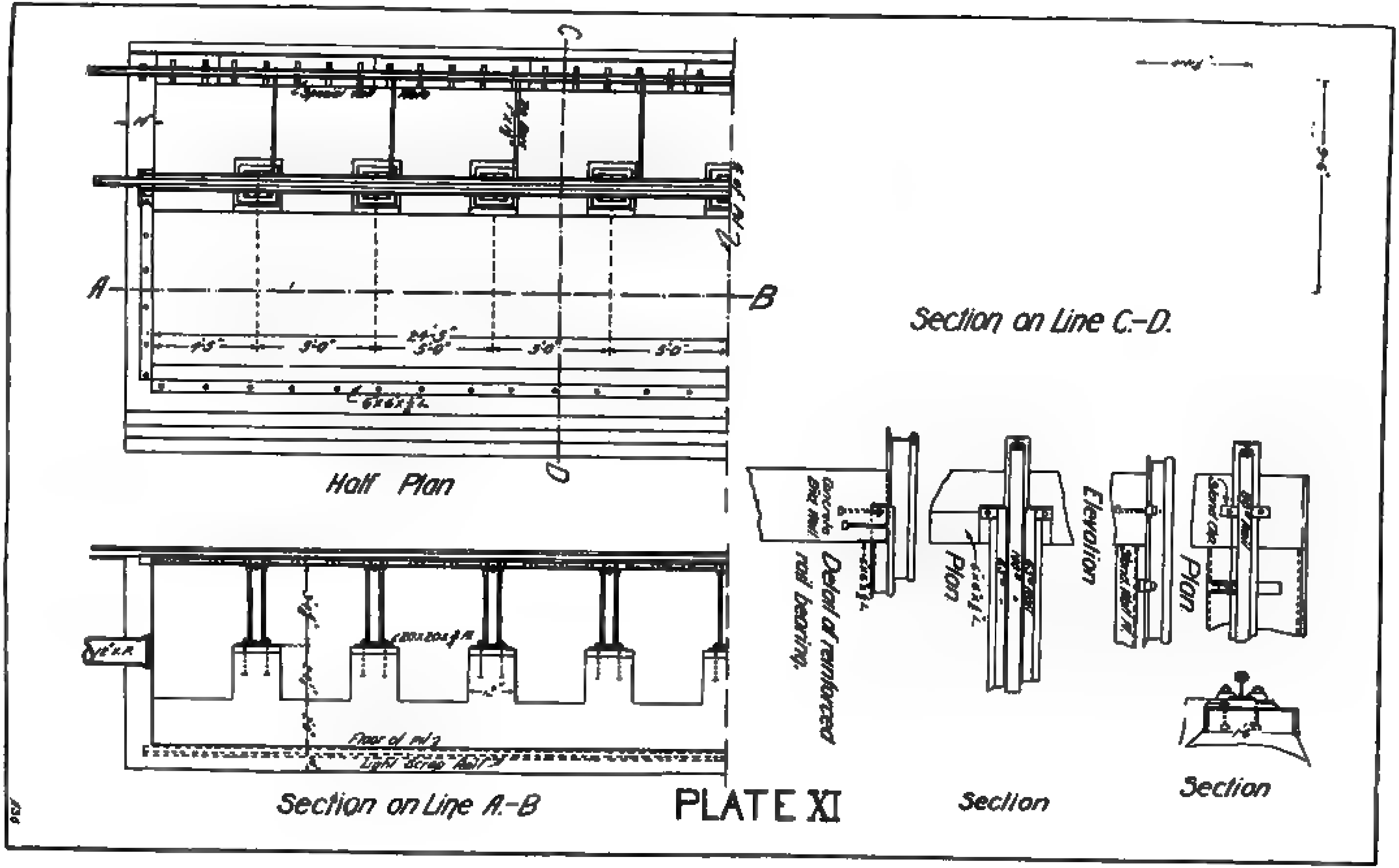


PLATE XI

Cinder Pit, Lake Shore & Michigan Southern Ry., Hillsdale, Mich.

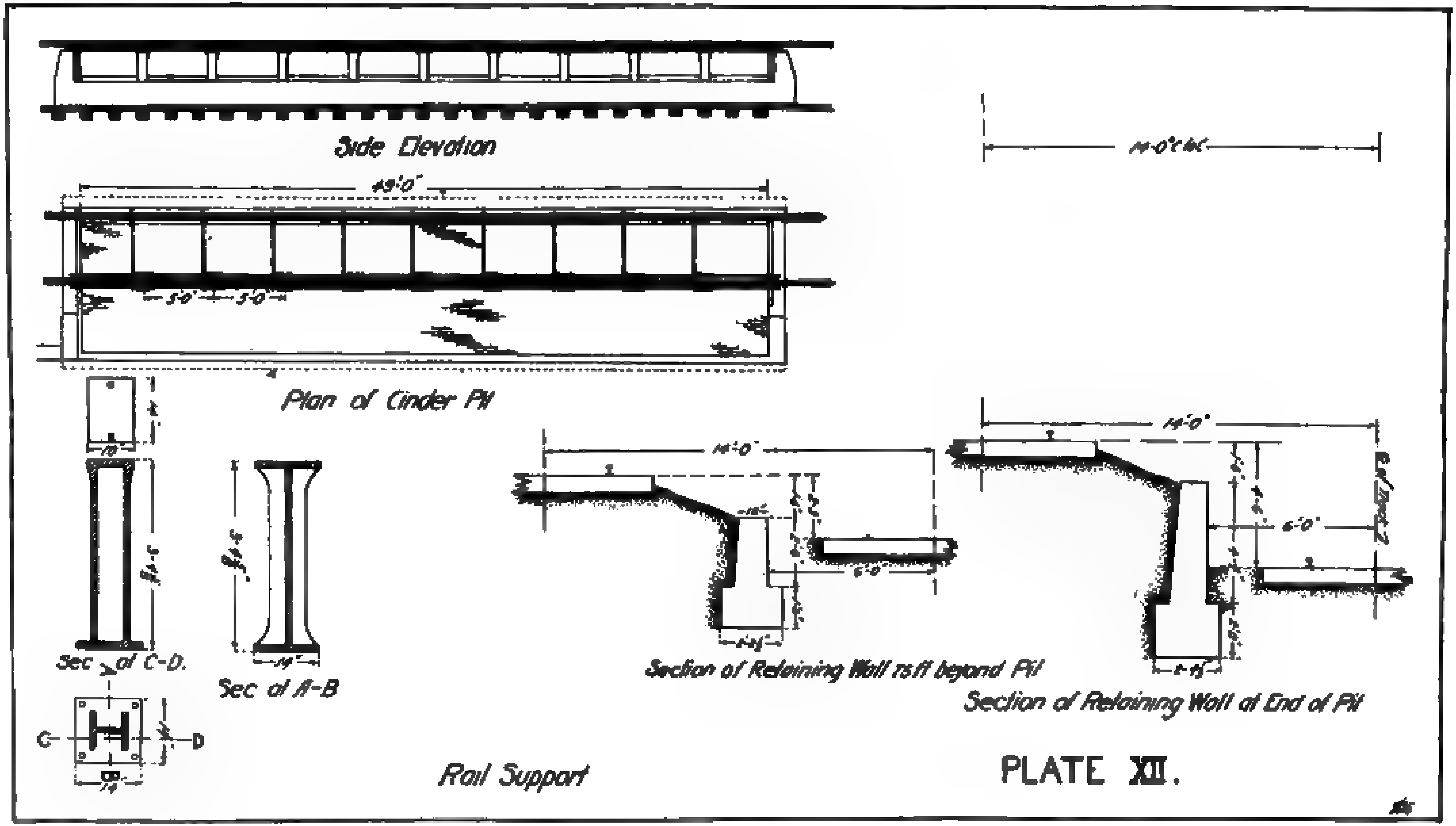
Number of cars of cinders loaded,	30.75	13.75	44.5
Cu. yds. of cinders handled, ...	1,417.6	207	1714.6
Cost per cu. yd. of cinders handled,..	$ .22	$ .35	
For each man employed, per day, ...	8.4	5.3	7.6

From these figures it would appear that engines were handled over the pneumatic conveyor at 29 cents each, while over the open side pit the cost was 18.4 cents each. This statement, however, is not a fair comparison of the two schemes, as the engines handled over the pneumatic conveyor were nearly all heavy equipment, whereas, those handled over the open side pit were largely switch engines and other light types. From the quantity of cinders handled it is seen that the heavy equipment averaged 1.3 cubic yards of cinders per locomotive, while the engines handled over the open pit averaged only .53 cubic yards. Then again if we figure the cost of handling cinders we find that at the pneumatic conveyor the cost was 22 cents per yard while at the open side pit it was 35 cents per yard.

Neither the cost per engine nor the cost per cubic yard for handling cinders, when taken separately, is a fair basis for comparison in this case. A fair comparison can only be obtained by handling the same equipment over the two plants. With these two sets of figures, however, it seems there is very little, if any, economy in using a pneumatic conveyor as compared with the open side pit. This was probably due to the fact that the fire knockers were not continuously employed at the conveyor. It would therefore mean no additional labor cost for these men to load the cinders when not engaged in cleaning engines. The time between cleaning engines was not sufficient to allow these men to be withdrawn from the conveyor and employed at other work. Therefore all of their time was charged to handling cinders whether they were busy or not. It is quite possible that under other conditions the pneumatic conveyor would furnish more favorable results.

The pits shown on Plates 8, 9, 12 and 13 are usually constructed with masonry walls, hard burned brick, stone or concrete being generally employed. Fire brick are frequently used for the shoveling floor and walls, as shown on Plates 12 and 13. Hard burned brick appear to be giving good satisfaction as they stand the heat from the cinders and chilling from cold water better than stone or concrete. This is especially true of the shoveling floor. A recent examination of pits constructed with concrete walls showed that in from two to five years the walls where subjected to hot cinders had disintegrated to a depth of from one to three inches. It is also a well-known fact that stone masonry disintegrates under such conditions. It is therefore the opinion of the committee that hard burned brick, or fire brick, are satisfactory materials for such parts of the pits as come in contact with hot cinders. For the other walls of the pits brick, stone and concrete have given good results. Where stone or concrete walls have become disintegrated from the action of hot cinders and cold water it is frequently possible to protect them from further damage by facing them with a single course of hard-burned brick or fire brick.

Owing to the rapid wear on the shoveling floor a material should be used that permits of easy repair; brick is good for this use. In some instances the shoveling floor is made of concrete and placed 6 in. below the required height. When the concrete floor has worn



Cinder Pit, Lake Shore & Michigan Southern Ry., Ft. Wayne, Ind.

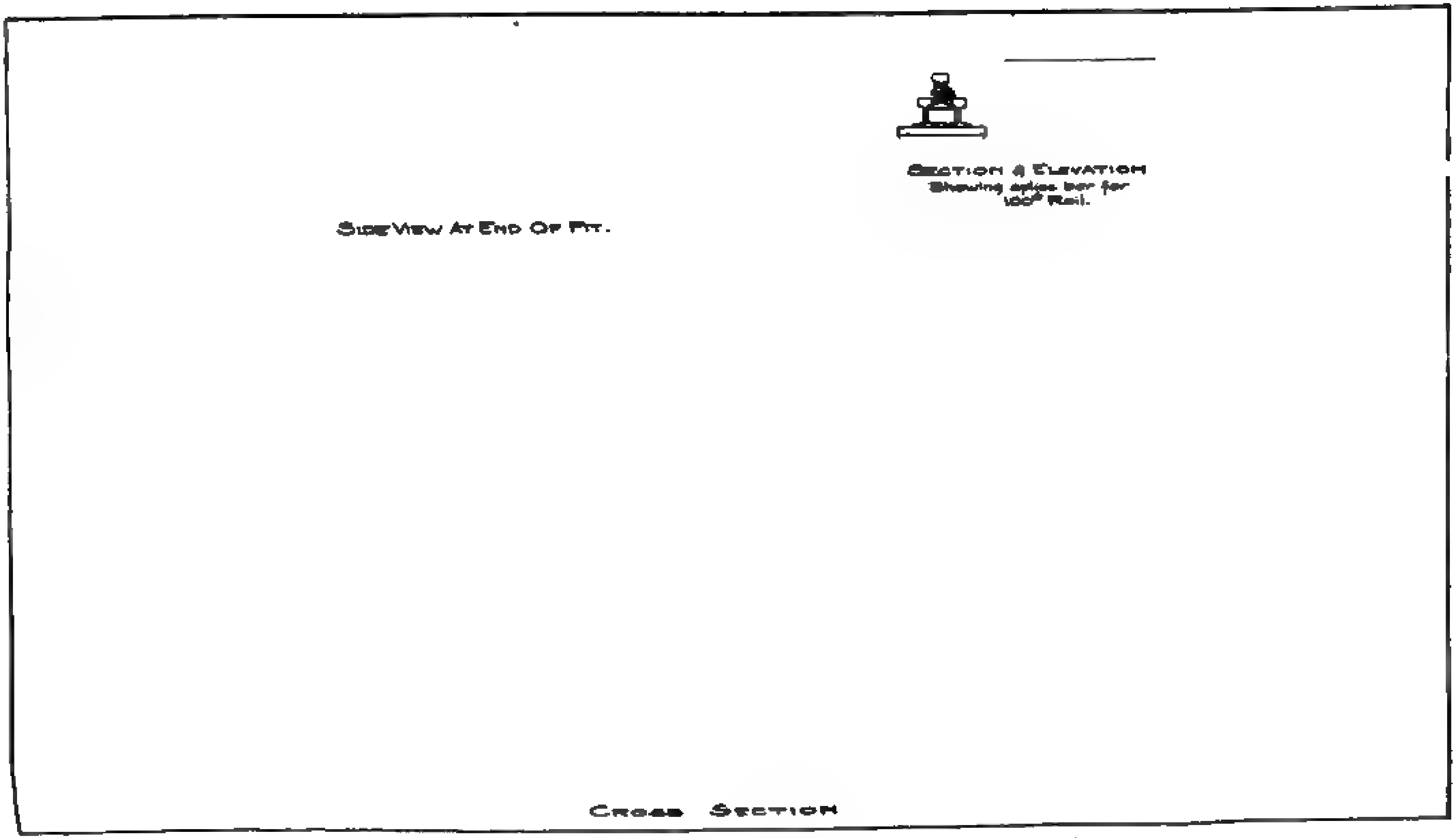


Plate XIII Cinder Pit Lake Shore & Michigan Southern Ry Ashtabula O.

out a course of hard-burned brick or fire brick, set on edge, is laid over it.

From such information as the committee has been able to secure, it is their opinion that the open side pit is the most satisfactory method of handling cinders from locomotives under ordinary conditions at terminals. Special conditions, however, might justify other methods.

Attention is called to the subject of Cinder Pits, on page 101 of the Sixteenth Proceedings.

SUPPLEMENTARY REPORT.

Ed. Gagnon, Minneapolis & St. Louis R. R.:

In regard to subject No. 13, will say that we are using nothing but the White patent pocket coal chute with pile bridge incline approach, cars being handled with engines. This we think is the best and cheapest coaling station. We figure that a six-pocket coal chute and three-pile bent incline approach 500 ft. long costs about $5,000. If the pockets are well put up and lined with steel plates, fastened with carriage bolts, there is no reason why these chutes will not last ten years without repair. We have had perfect success with this chute for the past 16 to 18 years with very little expense. The cost of transferring the coal from cars to chute pockets is uncertain, but in the past two years it has cost from nine to ten cents per ton on account of scarcity of labor. Referring to other types of chutes, I have little to say. The McHenry patent and similar types with chain and bucket drive propelled by gasoline or steam have proven very expensive in regard to repairs. My reason for this statement is that I have the opportunity to check bills which come from other companies using various makes.

I have heard of coal being handled by the McHenry chutes for five cents per ton, but considering the repairs I find that it averages more than the White patent.

We are about to construct a new chute in Minneapolis, and on account of cramped quarters we will make use of the McHenry pattern.

F. J. Bechley, Supt. Illinois Central Ry.:

We have a Browning No. 2 Crane at Waterloo, Iowa, that is used in handling storage coal. The cost of unloading coal cars is 3½ cents per ton, and from storage bin to locomotives 4½ cents per ton. During the time storage coal is used, we average handling approximately 4,000 tons per month.

As to spontaneous combustion in storage coal, beg to advise that some trouble has been experienced from this source where coal is stored in bins in large quantities; no difficulty of that kind, however, has occurred where coal is piled outside on the ground. It is estimated that there is a loss of approximately 5 per cent in the heating qualities of Illinois bituminous coal the first six months after it has been put in storage; after that about 2 per cent per year.

A. E. Killam, Intercolonial Ry. of Canada:

We have quite a variety of coaling stations in use on our road. We have one at Moncton which is known as the Hunt type. The

foundation and superstructure for this chute cost $9,140, and the machinery $6,000, or a total of $15,140, which makes it too expensive for general use. Further, it costs about 15 cents per ton to handle the coal. We have erected a number of coaling stations this year as shown on Plate 5. These are fitted out with steam crane and grab shovel.

Coaling Station with Locomotive Hoist, B. & L. E. R. R.:

The Bessemer & Lake Erie R. R. has recently erected a number of coaling stations of a design borrowed from the Baltimore & Ohio R. R., in which the pockets rest normally at ground level while being filled, and are then hoisted by locomotive power to an elevation suitable for loading the tender by gravity flow. The B. & L. E. R. R. has four of these stations, the one at Conneautville, Pa., being shown in the photographic illustration, Fig. 15. The design is very simple, consisting of an upright framework of 12x12-in. timbers to serve as guides for the pocket, with two hoisting sheaves at the top and another at the bottom. The movable pocket has the usual inclined bottom, and its top is at a convenient height for unloading by hand from a gondola car on side-track, at the rear of the structure. The capacity of each pocket is six tons of coal. At the front side there is a gate and drop apron or chute for admitting coal to the tenders. The gate is of such pattern that the quantity of coal discharged can be regulated at will.

The locomotive to be coaled does its own hoisting, the hoisting cable being of such length that, when the loop at the end thereof is hooked over the pilot beam, the pocket will be hoisted to the desired height by the time the locomotive has pulled ahead far enough to bring the tender opposite the pocket. The pocket being emptied, the locomotive backs up and lets it down again. In the station referred to there are duplicate pockets, one for loading in either direction.

Figure 16 shows the framing and general plans, and Fig. 14 the details of the hoisting pocket, all of which are so simple that but little verbal description need be added. The pocket is merely a strong box securely held with bolts at the four corners, with a piece of 100-lb. rail caught under the top timbers of the pocket, to which the hoisting cable is attached.

These coaling stations are cheaply constructed and require but little or no attendance, aside from the work of unloading the coal from the cars, and we are informed that they are operated with good satisfaction. We understand that there is nothing about the arrangement that is patented. We are indebted to the *Railway and Engineering Review* for the above descriptive data and for the use of the illustrations.

F. E. King,
M. J. Flynn,
P. J. O'Neil,
Ed. Gagnon,
W. W. Perry,
Committee.

DISCUSSION.

Mr. O'Neill.—Referring to the photographic illustration in the report of the Lake Shore & Michigan Southern Ry. cinder pit, I may say that the cinders are removed from the pit with a clam-shell shovel and we find it a very cheap method of getting the cinders out.

Mr. Storck.—We have under construction now a coaling station which will cost between $82,000 and $83,000, built out of concrete, by the Link Belt Engineering Works. I have no plan of it here, but may be able to get one later. It is a very elaborate station.

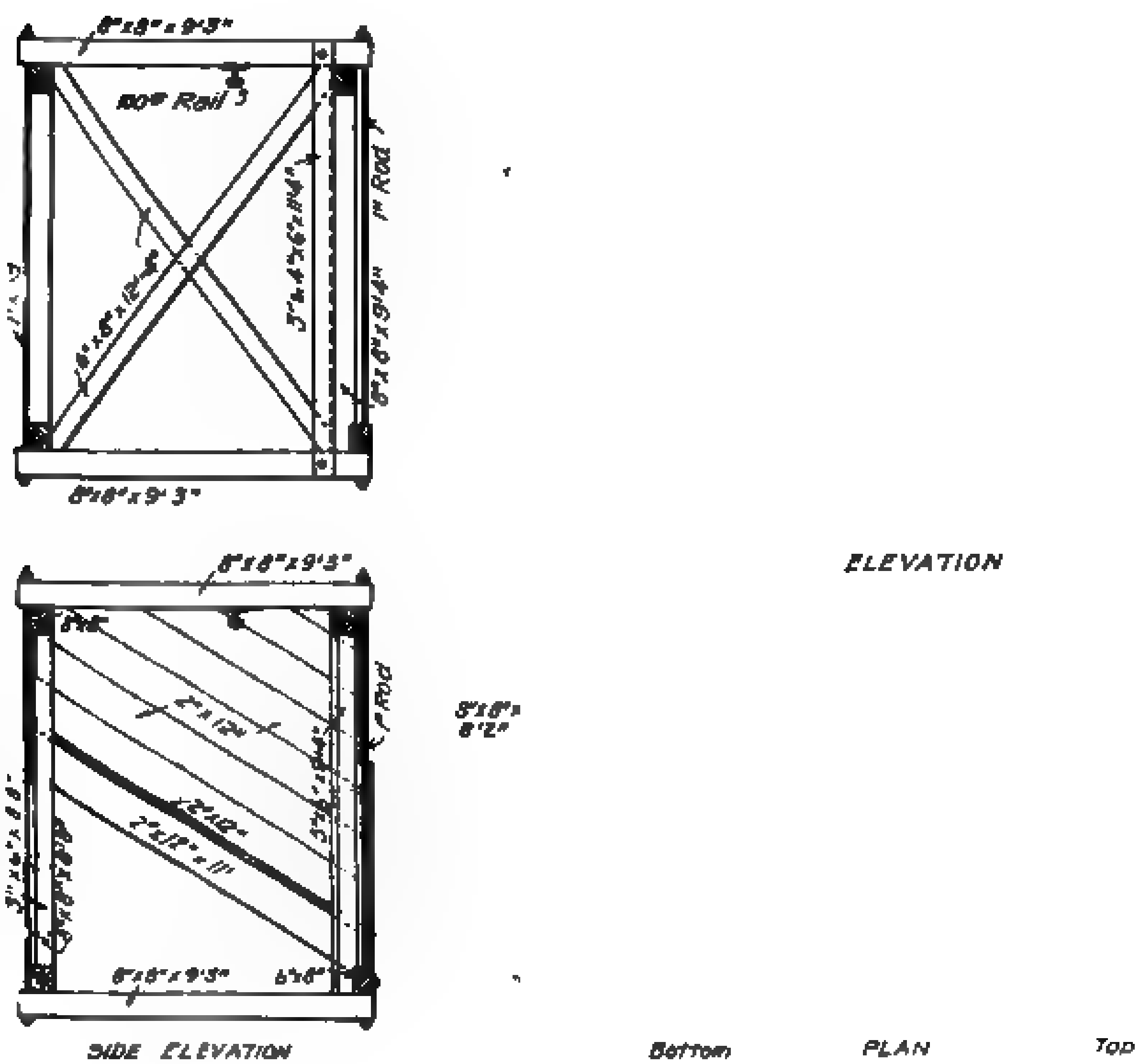


Fig. 14—Details of Hoisting Pocket, B. & L. E. R. R. Coaling Stations.

Fig. 15—Locomotive Coaling Station with Hoisting Pockets, Bessemer & Lake Erie R. R., Conneautville, Pa.

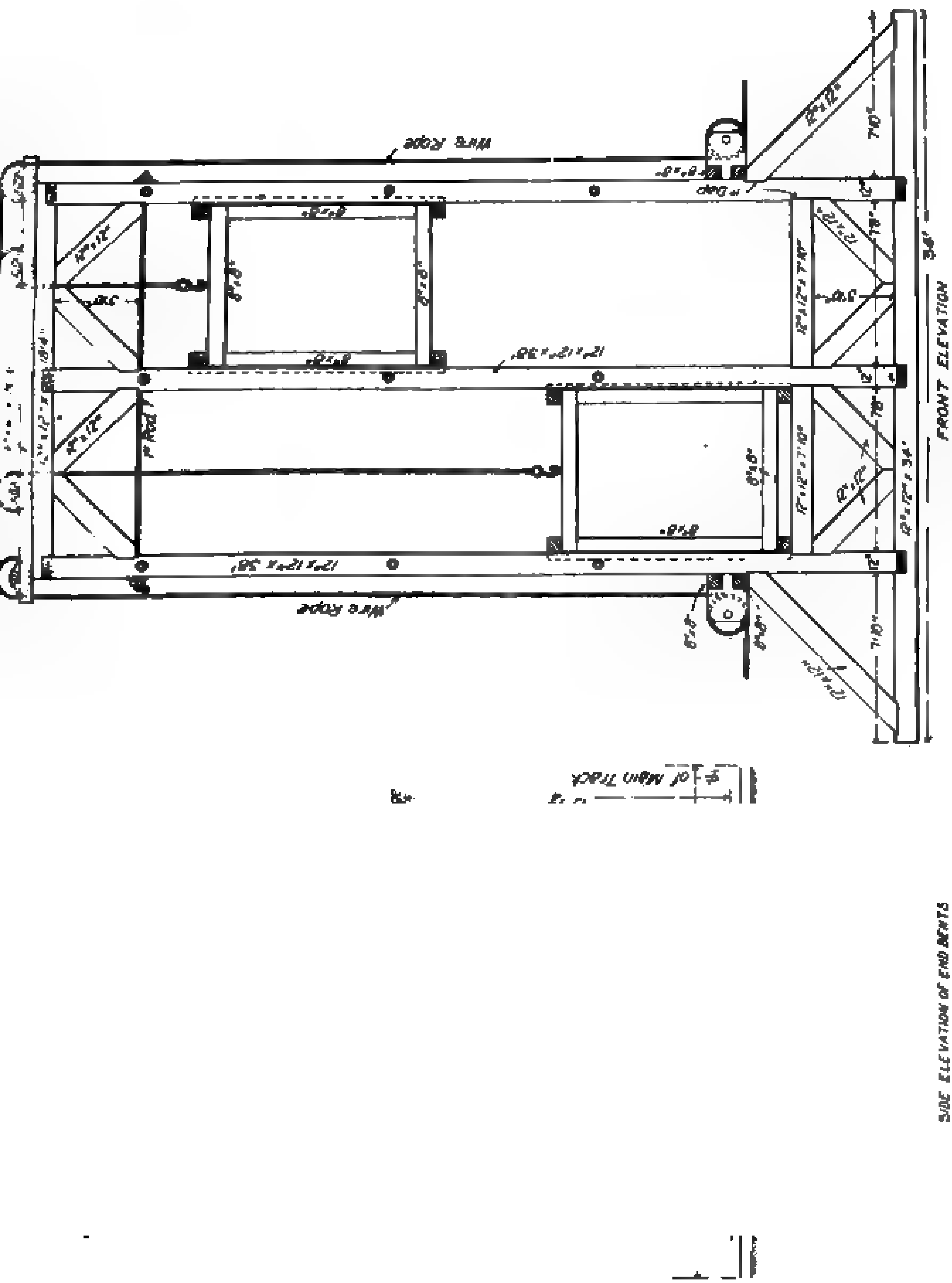


Fig. 16—Details of Locomotive Coaling Station with Hoisting Pockets, Bessemer & Lake Erie R. R.

Note: This Association received its present name at the Washington Convention, in 1908. Prior to that time it was named Association of Railway Superintendents of Bridges and Buildings.

LIST OF ANNUAL CONVENTIONS.

No.	Place.	Date.	Membership.
1	St. Louis, Mo.,	Sept. 25, 1891.	60
2	Cincinnati, Ohio,	Oct. 18-19, 1892.	112
3	Philadelphia, .Pa.,	Oct. 17-19, 1893	128
4	Kansas City, Mo.,	Oct. 16-18, 1894	115
5	New Orleans, La.,	Oct. 15-16, 1895	122
6	Chicago, Ill.,	Oct. 20-22, 1896	140
7	Denver, Col.,	Oct. 19-21, 1897	127
8	Richmond, Va.,	Oct. 18-19, 1898	148
9	Detroit, Mich.,	Oct. 17-18, 1899	148
10	St. Louis, Mo.,	Oct. 16-18, 1900	143
11	Atlanta, Ga.,	Oct. 15-17, 1901	171
12	Minneapolis, Minn.,	Oct. 21-23, 1902	195
13	Quebec, Canada,	Oct. 20-22, 1903	223
14	Chicago, Ill.,	Oct. 18-20, 1904	293
15	Pittsburg, Pa.,	Oct. 17-19, 1905	313
16	Boston, Mass.,	Oct. 16-18, 1906	340
17	Milwaukee, Wis.,	Oct. 15-17, 1907	341
18	Washington, D. C.,	Oct. 20-22, 1908	368
19	Jacksonville, Fla.,	Oct. 19-21, 1909	393

	1891-2.	1892-3.	1893-4.	1894-5.
President	O. J. Travis....	H. M. Hall......	J. E. Wallace....	Geo. W. Andrews.
First Vice-President	H. M. Hall......	J. E. Wallace....	Geo. W. Andrews..	W. A. McGonagle.
Second Vice-President..	J. B. Mitchell...	G. W. Hinman..	W. A. McGonagle.	L. K. Spafford.
Third Vice-President....	James Stannard..	N. W. Thompson	L. K. Spafford....	James Stannard.
Fourth Vice-President...	G. W. Hinman...	C. E. Fuller....	E. D. Hines......	Walter G. Berg.
Secretary	C. W. Gooch....	S. F. Patterson..	S. F. Patterson....	S. F. Patterson.
Treasurer	George M. Reid..	George M. Reid..	George M. Reid..	George M. Reid.
Executive Members..	W. R. Damon...	G. W. Andrews..	Q. McNab	James Stannard.
	G. W. Markley..	J. M. Staten....	A. S. Markley....	James H. Travis.
	W. A. McGonagle	J. M. Caldwell..	Floyd Ingram.....	J. H. Cummin.
	G. W. McGehee..	Q. McNab.......	James Stannard ..	R. M. Peck.
	G. W. Turner....	Floyd Ingram...	James H. Travis ..	J. L. White.
	J. E. Wallace....	A. S. Markley...	J. H. Cummin	A. Shane.

	1895-6.	1896-7.	1897-8.	1898-9.
President,	W. A. McGonagle	James Stannard..	Walter G. Berg....	J. H. Cummin.
First Vice-President,	L. K. Spafford..	Walter G. Berg..	J. H. Cummin....	A. S. Markley.
Second Vice-President...	James Stannard..	J. H. Cummin...	A. S. Markley....	C. C. Mallard.
Third Vice-President, ..	Walter G. Berg..	A. S. Markley...	G. W. Hinman....	W. A. Rogers.
Fourth Vice-President...	J. H. Cummin..	R. M. Peck....	C. C. Mallard.....	J. M. Staten.
Secretary,	S. F. Patterson..	S. F. Patterson..	S. F. Patterson....	S. F. Patterson.
Treasurer,	George M. Reid..	N. W. Thompson	N. W. Thompson..	N. W. Thompson.
Executive Members..	R. M. Peck.....	W. O. Eggleston.	G. J. Bishop......	Wm. S. Danes.
	J. L. White....	W. M. Noon....	C. P. Austin......	J. H. Markley.
	A. Shane	J. M. Staten....	M. Riney	W. O. Eggleston.
	A. S. Markley...	G. J. Bishop.....	Wm. S. Danes....	R. L. Heflin.
	W. M. Noon....	C. P. Austin....	J. H. Markley....	F. W. Tanner.
	J. M. Staten....	M. Riney	W. O. Eggleston..	A. Zimmerman.

	1899-1900.	1900-1901.	1901-1902.	1902-1903.
President,	Aaron S. Markley	W. A. Rogers	W. S. Danes	B. F. Pickering.
First Vice-President,	W. A. Rogers	W. S. Danes	B. F. Pickering	C. C. Mallard.
Second Vice-President	J. M. Staten	B. F. Pickering	A. Shane	A. Shane.
Third Vice-President,	Wm. S. Danes	A. Shane	A. Zimmerman	A. Zimmerman.
Fourth Vice-President	B. F. Pickering	A. Zimmerman	C. C. Mallard	A. Montzheimer.
Secretary,	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson.
Treasurer,	N. W. Thompson	N. W. Thompson	N. W. Thompson	N. W. Thompson.
Executive Members	T. M. Strain	T. M. Strain	A. Montzheimer	W. E. Smith.
	R. L. Heflin	H. D. Cleaveland	W. E. Smith	A. W. Merrick.
	F. W. Tanner	F. W. Tanner	A. W. Merrick	C. P. Austin.
	A. Zimmerman	A. Montzheimer	C. P. Austin	C. A. Lichty.
	H. D. Cleaveland	W. E. Smith	C. A. Lichty	W. O. Eggleston.
	A. Montzheimer.	A. W. Merrick	W. O. Eggleston	J. H. Markley.

	1903-1904.	1904-1905.	1905-1906.	1906-1907.
President,	A. Montzheimer	C. A. Lichty	J. B. Sheldon	J. H. Markley.
First Vice-President,	A. Shane	J. B. Sheldon	J. H. Markley	R. H. Reid.
Second Vice-President	C. A. Lichty	J. H. Markley	R. H. Reid	J. P. Canty.
Third Vice-President,	J. B. Sheldon	R. H. Reid	R. C. Sattley	H. Rettinghouse.
Fourth Vice-President	J. H. Markley	R. C. Sattley	J. P. Canty	F. E. Schall.
Secretary,	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson.
Treasurer,	C. P. Austin	C. P. Austin	C. P. Austin	C. P. Austin.
Executive Members	R. H. Reid	W. O. Eggleston	H. Rettinghouse	W. O. Eggleston
	W. O. Eggleston	A. E. Killam	A. E. Killam	A. E. Killam.
	A. E. Killam	H. Rettinghouse	J. S. Lemond	J. S. Lemond.
	R. C. Sattley	J. S. Lemond	C. W. Richey	C. W. Richey.
	H. Rettinghouse	W. H. Finley	H. H. Eggleston	H. H. Eggleston.
	J. S. Lemond	C. W. Richey	F. E. Schall	B. J. Sweatt.

	1907-1908.	1908-1909.	1909-1910.	1910-1911.
President,	R. H. Reid	J. P. Canty	J. S. Lemond	
First Vice-President,	J. P. Canty	H. Rettinghouse	H. Rettinghouse	
Second Vice-President	H. Rettinghouse	F. E. Schall	F. E. Schall	
Third Vice-President,	F. E. Schall	J. S. Lemond	A. E. Killam	
Fourth Vice-President	W. O. Eggleston	A. E. Killam	J. N. Penwell	
Secretary,	S. F. Patterson	S. F. Patterson	C. A. Lichty	
Treasurer,	C. P. Austin	C. P. Austin	J. P. Canty	
Executive Members	A. E. Killam	J. N. Penwell	W. Beahan	
	J. S Lemond	Willard Beahan	F. B. Scheetz	
	C. W. Richey	F. B. Sheetz	T. L. D. Hadwen	
	T. S. Leake	W. H. Finley	T. J. Fullem	
	W. H. Finley	T. L. D. Hadwen	G. Aldrich	
	J. N. Penwell	T. J. Fullem	P. Swenson	

CONSTITUTION

ARTICLE I.

NAME.

SECTION 1. This association shall be known as the American Railway Bridge & Building Association.

ARTICLE II.

OBJECT.

SECTION 1. The object of this association shall be the advancement of knowledge pertaining to the principles, design, construction and maintenance of railway bridges, buildings and other structures, by investigation, reports and discussion of the experience of its members and others, and to provide a means of exchange of ideas, so that bridge and building practice may be systematized and improved.

SECT. 2. The association shall neither endorse nor recommend any particular patents, materials or supplies, but individual opinions of members may be expressed and appear in the proceedings.

ARTICLE III.

MEMBERSHIP.

SECTION 1. The membership of this association shall consist of two classes, active and life members.

SECT. 2. A person who is actively engaged in railway service in a responsible position, in charge of work connected with the construction or maintenance of railway bridges and buildings or other structures, or a professor of engineering, government, timber expert, or railroad architect shall be eligible for active membership upon application to the secretary, and the payment of three dollars membership fee, and two dollars for one year's dues.

SECT. 3. Any member elected a life member of this association shall have all the privileges of an active member, but shall not be required to pay annual dues. To be elected a life member he must have been a member of the association at least five years and before being elected must have been pensioned by the railway company for which he worked or shall have retired from active railway service.

SECT. 4. Any member guilty of dishonorable conduct, or conduct unbecoming a railroad official and member of this association, or who shall refuse to obey the chairman, or rules, may be expelled by a two-thirds vote of the members present.

SECT. 5. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled.

ARTICLE IV.

OFFICERS.

SECTION 1. The officers of this association shall be a president, four vice-presidents, a secretary, a treasurer, and six executive members.

SECT. 2. The executive members, together with the president, vice-presidents, secretary and treasurer, shall constitute the executive committee.

SECT. 3. Past presidents of this association who continue to be members shall be entitled to be present at all meetings of the executive committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past-presidents shall not have a right to vote, nor shall their presence be requisite in order to constitute a quorum.

SECT. 4. Vacancies in any office for the unexpired term shall be filled by the executive committee without unnecessary delay.

ARTICLE V.

EXECUTIVE COMMITTEE.

SECTION 1. The executive committee shall exercise a general supervision over the financial interests of the association, assess the amount of annual and other dues, call, prepare for and conduct general or special meetings, make all necessary purchases and contracts required to conduct the general business of the association, but shall not have the power to render the association liable for any debt beyond the amount then in the treasurer's hands not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the association.

SECT. 2. Two thirds of the members of the executive committee may call special meetings, thirty days' notice being given members by mail.

SECT. 3. Five members of the executive committee shall constitute a quorum for the transaction of business.

ARTICLE VI.

ELECTION OF OFFICERS AND TENURE OF OFFICE.

SECTION 1. The officers, excepting as otherwise provided, shall be elected at the regular meeting of the association, held on the third Tuesday in October of each year, and the election shall not be postponed except by unanimous consent.

SECT. 2. The president and treasurer shall be elected by ballot by a majority of votes cast, and shall hold office for one year or until successors are elected. No member in arrears shall be eligible for office, and the president shall not be eligible for re-election.

Vice-Presidents and Executive Members.

SECT. 3. The vice-presidents shall hold office for one year and executive members for two years; four vice-presidents and three executive members to be elected each year; all officers herein named to hold office until successors are chosen.

SECT. 4. In the election of vice-presidents, each one shall be elected by a majority vote. Executive members shall be elected in the same way, all voting to be by written ballots.

Secretary.

SECT. 5. A secretary shall be elected by a majority of the votes of the members present at the annual meeting. The term of office of the secretary shall be for one year, unless terminated sooner by action of the executive committee, two thirds of whom may remove the secretary at any time. His compensation shall be fixed by a majority of the executive committee. The secretary shall also be secretary of the executive committee.

Treasurer.

SECT. 6. The treasurer shall be required to give bond in an amount to be fixed by the majority of the executive committee.

ARTICLE VII.

COMMITTEES.

Nominating Committee.

SECTION 1. After each annual meeting the president shall appoint a committee of five members, not officers of the association, of whom two at least shall be past presidents, and two of whom shall have served on the committee the previous year. They shall prepare a list of names of nominees for officers to be voted on at the next annual convention, agreeable to Article VI. of this constitution, said list to be read at the first session of the second day of said convention. Nothing in this section shall be construed to prevent any member making nominations.

Auditing Committee.

SECT. 2. At the first session of each annual meeting there shall be appointed by the president an auditing committee of three members, not officers of the association, whose duty it shall be to examine the accounts and vouchers of the secretary and treasurer and certify as to the correctness of their accounts. Acceptance of this committee's report will be regarded as the discharge of the committee.

Committee on Subjects for Discussion.

SECT. 3. At the annual meeting there shall be appointed, by the president, a committee, whose duty it shall be to prepare and report subjects for investigation and discussion at the next annual meeting. It shall be the duty of the committee to receive from members questions for discussion during the time set apart for that purpose. This committee shall decide whether such questions are suitable ones for discussion, and if approved, report them to the association.

Committees on Investigation.

SECT. 4. When the committee on subjects has reported and the association approved of the same, the president shall appoint special committees to investigate and report on said subjects and he may appoint a special committee to investigate and report on anv subject of which a majority of members present may approve.

Publication Committee.

SECT. 5. After each annual meeting the executive committee shall appoint a publication committee of three active members whose duty it shall be to supervise the publication of the proceedings. The assignment of this committee shall be such that at least one member shall have served on the committee during the previous year. The publication committee will report to the president and perform their duties under his supervision.

ARTICLE VIII.

ANNUAL DUES.

SECTION 1. Every active member shall pay to the secretary three dollars membership fee and shall also pay two dollars per year in advance to defray the necessary expenses of the association. No member being one year in arrears for dues shall be entitled to vote at any election, and any member one year in arrears may be stricken from the list of members at the discretion of the executive committee.

ARTICLE IX.

AMENDMENTS.

SECTION 1. This constitution may be amended at any regular meeting by a two thirds vote of members present, provided that a written notice of the proposed amendment, or amendments, has been given at least sixty days previous to said regular meeting.

BY-LAWS

TIME OF MEETING.

1. The regular meeting of this association shall be held annually on the third Tuesday in October.

HOUR OF MEETING.

2. The regular hour of meeting shall be at 10 o'clock a. m., unless changed by order of the presiding officer.

PLACE OF MEETING.

3. The cities or places for holding the annual convention may be proposed at any regular meeting of the association before the final adjournment. The places proposed shall be submitted to a ballot vote of the members of the association, the city or place receiving a majority of all the votes cast to be declared the place of the next annual meeting; but if no place received a majority of all votes, then the place receiving the lowest number of votes shall be dropped on each subsequent ballot until a place is chosen.

QUORUM.

4. At the regular meeting of the association, fifteen or more members shall constitute a quorum.

ORDER OF BUSINESS.

5. 1st—Calling of roll.
 2nd—Reading minutes of last meeting.
 3rd—Admission of new members.
 4th—President's address.
 5th—Reports of secretary and treasurer.
 6th—Payment of annual dues.
 7th—Appointment of committees.
 8th—Reports of committees.
 9th—Unfinished business.
 10th—New business.
 11th—Reading and discussion of questions propounded by members.
 12th—Miscellaneous business.
 13th—Election of officers.
 14th—Adjournment.

(Report of nominating committee to be read at first session of second day.)

DUTIES OF OFFICERS.

6. The president shall have general supervision of the affairs of the association. He shall preside at all meetings of the association, and of the executive committee, at which he may be present; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. He shall, with

the secretary, sign all contracts or other written obligations of the association which have been approved by the executive committee.

At the annual meeting the president shall present a report containing a statement of the general condition of the association, and an address.

7. The vice-presidents in order of seniority shall preside at meetings in the absence of the president, and discharge his duties in case of a vacancy in his office.

8. It shall be the duty of the secretary to keep a correct record of proceedings of all meetings of this association; to keep correct all accounts between this association and its members; collect all moneys due the association, and pay the same over to the treasurer and take his receipt therefor, and to perform such other duties as the association may require.

9. The treasurer shall receive all moneys and deposit the same in the name of the association and shall receipt to the secretary therefor. He shall invest all funds not needed for current disbursements as shall be ordered by the executive committee. He shall pay all bills, when properly certified and approved by the president, and make such reports as may be called for by the executive committee.

DECISIONS.

10. The votes of a majority of members present shall decide any question, motion or resolution which shall be brought before the association, unless otherwise provided.

DISCUSSIONS.

11. All discussions shall be governed by Robert's rules of order.

DIRECTORY OF MEMBERS.

A.

Aagaard, P., Supvr. B. and B., I. C. R. R., Chicago, Ill.

Aldrich, Grosvenor, Bridge Supvr. N. Y., N. H. & H. R. R., Readville, Mass.

Alexander, W. E., Supt. of Bridges, B. & A. R. R., Houlton, Me.

Amos, Alexander, M. St. P. & S. Ste. M. Ry., Minneapolis, Minn.

Anderson, August, Gen'l. For. B. and B., L. S. & I. Ry., Marquette, Mich.

Anderson, J. W., Supt. B. and B., C H. & D. Ry., Chillicothe, Ohio.

Anderson, L. J., For. B. and B., C. & N. W. Ry., Escanaba, Mich.

Andrews, G. W., Insp. Maint. B. & O. R. R., Baltimore, Md.

Andrews, O. H., Supt. B and B., St. J. & G. I. Ry., St. Joseph, Mo.

Arey, R. J., Div. Engineer, A. T. & S. F. Ry., San Bernardino, Cal.

Ashby, E. B., Chief Engr., L. V. R. R., New York City.

Auge, E. J., Chief Carp., C. M. & St. P. Ry., Wells, Minn.

Austin, C. P., Supvr. B. and B., B. & M. R. R., Lawrence, Mass.

B.

Bailey, F. W., Supvr. B. and B., M. K. & T. Ry., Denison, Tex.

Bailey, S. D., Div. For. of Buildings, M. C. R. R., Detroit, Mich.

Ball, E. E., Div. Engr., A. T. & S. F. Ry., Winslow, Ariz.

Ballenger, D. A., Roadmaster, Southern Ry., Greenville, S. C.

Barker, W. M., Br. Foreman, Seaboard Air Line Ry., Scotia, S. C.

Barrett, E. K., Supvr. B. and B., F. E. C. Ry., St. Augustine, Fla.

Barrett, J. E., Supt. of Track and B. and B., L. & H. R. Ry., Warwick, N. Y.

Bartles, F. R., Supvr. B. and B., N. P. Ry., Fargo, N. D.

Barton, M. M., Master Carp., Penn, R. R., West Philadelphia, Pa.

Bates, Onward, Civil Engineer, 355 Dearborn St., Chicago, Ill.

Battey, C. C., Supvr. B. and B., B. & M. R. R., Concord, N. H.

Beahan, Willard, Asst. Engr., L. S. & M. S. Ry., Cleveland, Ohio.

Beal, F. D., Supt. Pacific Creosoting Co., Seattle, Wash.

Bean, C. C., Supvr. B. and B., I. C. R. R., Freeport, Ill.

Beard, A. H., For. Carp., P. & R. Ry., Reading, Pa.

Beckman, B. F., Supt. F. S. & W. R. R., Fort Smith, Ark.

Bender, Henry, Inspector C. & N. W. Ry., Chicago, Ill.

Bentele, Hans, Asst. Engr., National Rys. of Mexico, Mexico City, Mex.

Bennett, A. G., Asst. Engr., C. M. & St. P. Ry., Minneapolis. Minn.

Berry, J. S., Supvr. B. and B., S. L. S. W. Ry., Tyler, Tex.

Bibb, J. M., Supvr. B. and B., L. & N. R. R., Birmingham, Ala.

Bishop, G. J., Yoakum, Texas.

Bishop, McClellan, Master Carp., C. R. I. & P. Ry., El Reno. Okla.

Biss, C. H., Engr., New Zealand Govt. Rys., Christchurch, N. Z.

Blair, J. A., Master Carp., Penn. R. R., Pittsburg, Pa.

Bowers, S. C., Master Carp. of Bridges, P. C. C. & St. L. Ry., Steubenville, Ohio.

Bowers, Stanton, Master Carp., P. C. C. & St. L. Ry., Bradford, Ohio.

Bowman, A. L., Consulting Engr., Dept. of Bridges, New York City.

Bratten, T. W., Genl. For. B. and B., S. P. Co., West Oakland, Cal.

Briggs, B. A., Supvr. B. and B. and R. M., C. S. & C. C. D. Ry., Cripple Creek, Col.

Brown, Alf, Supt. B. & B., St. Louis, Rocky Mt. & Pac. R. R., Raton, N. M.

Brown, J. B., Genl. For. B. and B., K. C. C. & S. Ry., Clinton, Mo.

Browne, J. S., Div. Engr., N. Y. N. H. & H. R. R., Providence, R. I.

Bruce, R. J., Supvr. B. and B., M. P. Ry., St. Louis, Mo.

Burke, J. T., Chief Engr., Liberty-White R. R., McComb, Miss.

Burpee, Moses, Chief Engr., B. & A. R. R., Houlton, Maine.

Burpee, T. C., Engr. M. of W., Intercolonial Ry., Moncton, N. B.

Burrell, F. L., Genl. For. B. and B., C. & N. W. Ry., Fremont, Neb.

C.

Cable, C. C., Engr. Construction, Calle Cienfuegos, No. 30. Altos, Havana, Cuba.

Cahill, M. F., Master Carp., S. A. L. Ry., Jacksonville, Fla.

Cahill, P. W., For. Carpenter, S. A. L. Ry., Fernandina, Fla.

Caldwell, J. M., Insp. C. I. & L. R. R., Lafayette, Ind.

Canty, J. P., Supvr. B and B., B. & M. R. R., Fitchburg, Mass.
Cardwell, W. M., W. T. Co., Washington, D. C.
Carman, F. V., Gen. For. B. and B., S. P. Co., West Oakland, Cal.
Carmichael, William, El Reno, Okla.
Carpenter, J. T., Supvr. B. and B., Southern Ry., Princeton, Ind.
Carr, Charles, Supvr. Buildings, M. C. R. R., Jackson, Mich.
Carson, D. J., Master Carp., B. R. & P. Ry., Du Bois, Pa.
Carter, E. M., Supvr. B. and B., T. C. R. R., Nashville, Tenn.
Catchot, A. J., Supvr. B. & B., L. & N. R. R., Ocean Springs, Miss.
Causey, T. A., Lacygne, Linn County, Kansas.
Causey, W. B., Supt., C. G. W. Ry., Chicago, Ill.
Christy, B. B., Br. Foreman, S. A. L. Ry., Tallahassee, Fla.
Clark, W. A., Chief Engr., D. & I. R. R. R., Duluth, Minn.
Clark, W. M., Master Carp., B. & O. R. R., Glenwood, Pa.
Cleaveland, H. D., Master Carp. B. & L. E. R. R., Greenville, Pa.
Cookson, D. M., Asst. Engr. Z. C. Ry., Kyankpyu, Burma, India.
Cole, J. E., Genl. For. B. and B., C. V. R. R., St. Albans, Vt.
Collier, W. R., Supvr. B. and B., St. L. I. M. & S. Ry., Chester Ill.
Coombs, R. D., Const. Engr., 1112 Broadway, New York City.
Costolo, J. A., Supvr. B. and B., M. P. Ry., St. Louis, Mo.
Cothran, T. W., Prin, Asst. Engr., N. & S. Ry., Greenwood, S. C.
Cunningham, A. O., Chief Engr., Wabash R. R., St. Louis, Mo.
Curtin, William, Contractor, Govan, Saskatchewan.

D.

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McCormack, J. W., C. St. P. M. & O. Ry., Altoona, Wis.
McGehee, G. W., Mobile & Ohio R. R., Okolona, Miss.

Mellor, W. J., M. L. & T. R. R., Lafayette, La.
Millner, S. S., B. & O. S. W. Ry., Washington, Ind.
Mitchell, J. B., C. C. C. & St. L. Ry., Indianapolis, Ind.
Mitchell, W. B., N. Y. P. & O. R. R., Galion, Ohio.
Morgan, T. H., Gulf, Col. & S. F. Ry., Cleburne, Tex.
Peck, R. M., Mo. Pac. Ry., Pacific, Mo.
Reid, George M., L. S. & M. S. Ry., Cleveland, Ohio.
Reynolds, E. F., C. & N. W. Ry., Antigo, Wis.
Schwartz, John C., C. St. P. M. & O. Ry., Emerson, Neb.
Spafford, L. K., K. C. Ft. S. & M. Ry., Kansas City, Mo.
Spangler, J. A., B. & O. R. R., Washington, Pa.
Taylor, J. W., Term. R. R. Assn. of St. Louis, St. Louis, Mo.
Thompson, N. W., P. F. W. & C. Ry., Ft. Wayne, Ind.
Tozzer, Wm. S., C. & O. Ry., Cincinnati, Ohio.
Trautman, J. J., S. C. R. R., Edgefield, S. C.
Wallace, J. E., Wabash R. R., Springfield, Ill.
Welch, E. T., C. St. M. & O. Ry., Mankato, Minn.
Worden, C. G., S. F. Pac. R. R., Winslow, Ariz.

MEMBERSHIP AND MILEAGE OF RAILWAYS REPRESENTED.

Name of Road and Membership.	Members.	Mileage.
Atchison, Topeka & Santa Fé Ry	4	5,573
E. McCann, Wellington, Kan.		
John L. Talbott, Pueblo, Col.		
J. M. Wells, Chillicothe, Ill.		
M. R. Williams, Las Vegas, N. M.		
Atchison, Topeka & Santa Fé Ry. (Coast Lines)	4	1,974
R. J. Arey, San Bernardino, Cal.		
E. E. Ball, Winslow, Ariz.		
J. F. Parker, San Bernardino, Cal.		
D. A. Shope, Fresno, Cal.		
Atlanta & West Point R. R. and Western Ry. of Alabama	1	225
O. T. Nelson, Montgomery, Ala.		
Atlantic Coast Line R. R.	1	4,361
J. W. Salisbury, Port Tampa, Fla.		
Baltimore & Ohio R. R. and Baltimore & Ohio Southwestern R. R.	11	4,422
G. W. Andrews, Baltimore, Md.		
W. M. Clark, Glenwood, Pa.		
W. T. Hopke, Grafton, W. Va.		
J. T. McIlwain, Akron, O.		
William Renton, Garrett, Ind.		
W. F. Strouse, Washington, D. C.		
S. C. Tanner, Baltimore, Md.		
D. B. Taylor, Wheeling, W. Va.		
F. A. Taylor, Cumberland, Md.		
Wm. Trapnell, Baltimore, Md.		
E. C. Zinsmeister, Zanesville, O.		
Bangor & Aroostook R. R.	2	515
W. E. Alexander, Houlton, Me.		
M. Burpee, Houlton, Me.		
Bessemer & Lake Erie R. R.	1	210
H. D. Cleaveland, Greenville, Pa.		
Boston & Albany R. R.	1	392
W. F. Steffens, Boston, Mass.		

Name of Road and Membership.

Boston & Maine R. R. ....
Cyrus P. Austin, Lawrence, Mass.
C. C. Battey, Concord, N. H.
J. P. Canty, Fitchburg, Mass.
John Ewart, Boston, Mass.
Andrew B. Hubbard, Boston, Mass.
F. J. Leavitt, Sanbornville, N. H.
William A. Lydston, Salem, Mass.
John Marsh, Lawrence, Mass.
Albert Mountfort, Nashua, N. H.
A. A. Page, Wilmington, Mass.
S. F. Patterson, Concord, N. H.
B. F. Pickering, Sanbornville, N. H.
Fred C. Rand, Boston, Mass.
F. A. Sherwin, Springfield, Mass.
J. P. Snow, Boston, Mass.
E. C. Spaulding, St. Johnsbury, Vt.

Canadian Pacific Ry. ....
F. P. Gutelius, North Bay, Ont.
C. N. Monsarrat, Montreal, P. Q.
P. B. Motley, Montreal, P. Q.
Frank Lee, Winnipeg, Man.

Central of Georgia Ry. ....
A. M. Dodd, Columbus, Ga.
H. C. McKee, Macon, Ga.

Central R. R. of New Jersey ....
George F. Morse, New York City.

Central Vermont Ry. ....
J. E. Cole, St. Albans, Vt.
C. Donaldson, Waterbury, Vt.
C. F. Flint, St. Albans, Vt.
H. E. Holmes, New London, Conn.

Chesapeake & Ohio Ry. ....
F. M. Griffith, Covington, Ky.
Oscar L. Grover, Richmond, Va.
C. E. Powell, Hinton, W. Va.
J. M. Staten, Richmond, Va.
C. W. Vandegrift, Ronceverte, W. Va.

Chicago & Eastern Illinois R. R. ....
A. S. Markley, Danville, Ill.

Chicago & North Western Ry. ....
L. J. Anderson, Escanaba, Mich.
H. Bender Chicago.
F. L. Burrell, Fremont, Neb.
Henry Crane (retired), Janesville, Wis.
H. H. Decker, Belle Fourche, S. D.
T. H. Durfee, Huron, S. D
W. H. Finley, Chicago, Ill.
M. J. Flynn, Chicago, Ill.
G. W. Hand, Chicago, Ill.

Name of Road and Membership.	Members.	Mileage.
Chicago & North Western Ry. *Continued.*		
John Hunciker, Chicago, Ill.		
Lee Jutton, Chicago, Ill.		
C. F. King, Shoshoni, Wyo.		
C. A. Lichty, Chicago, Ill.		
George Loughnane, Escanaba, Mich.		
W. T. Main, Chicago, Ill.		
C. A. Marcy, Chicago, Ill.		
A. W. Merrick, Boone, Ia.		
W. F. Meyers, Belle Plaine, Ia.		
J. D. Moen, Boone, Ia.		
H. P. Morrill (retired), Madison, Wis.		
J. A. S. Redfield, Hawarden, Iowa.		
H. Rettinghouse, Boone, Ia.		
John Rhoads, Chicago, Ill.		
M. Riney, Baraboo, Wis.		
J. S. Robinson, Chicago, Ill.		
D. Rounseville, Antigo, Wis.		
A. R. Shedd, Chicago, Ill.		
Wm. Spencer, Chadron, Neb.		
I. F. Stern, Chicago, Ill.		
W. Sweeney, Green Bay, Wis.		
L. H. Taylor, Chicago, Ill.		
W. J. Towne, Chicago, Ill.		
H. M. Trippe, Chicago, Ill.		
H. A. Walden, Boone, Ia.		
W. D. Walden (retired), Clinton, Ia.		
J. B. White, Boone, Ia.		
Chicago, Burlington & Quincy R. R.	4	8,950
Geo. Fenney, McCook, Neb.		
Ed M. Gilchrist, Centerville, Ia.		
W. Hurst, St. Joseph, Mo.		
J. O. Thorne, Beardstown, Ill.		
Chicago Great Western Ry.	2	1,367
W. B. Causey, Chicago, Ill.		
J. E. Pickens, Dubuque, Ia.		
Chicago, Indianapolis & Louisville Ry.	1	578
J. M. Caldwell, Lafayette, Ind.		
Chicago, Milwaukee & St. Paul Ry.	12	8,502
(and C. M. & P. S. Ry.)		
E. J. Auge, Wells, Minn.		
A. G. Bennett, Minneapolis, Minn.		
H. R. Drum, Chamberlain, S. D.		
T. L. D. Hadwen, Chicago, Ill.		
F. E. King, Milwaukee, Wis.		
N. H. LaFountain, Chicago, Ill.		
C. F. Loweth, Chicago, Ill.		
William Ross, Millbank, S. D.		
Fred E. Weise, Chicago, Ill.		
William E. Wood, Marion, Ia.		
A. A. Wolf, Milwaukee, Wis.		
A. Yappen, Chicago, Ill.		

Name of Road and Membership.	Members.	Mileage.
Chicago, Rock Island & Pacific Ry.	4	7,414
McCellan Bishop, El Reno, Okla.		
E. R. Floren, Fairbury, Neb.		
B. M. Hudson, Ft. Worth, Tex.		
J. D. Upp, Colorado Springs, Col.		
Chicago, St. Paul, Minneapolis & Omaha Ry.	2	1,739
G. Larson, Hudson, Wis.		
W. B. Rogers, Emerson, Neb.		
Chicago Terminal Transfer R. R.	1	280
E. N. Layfield, Chicago, Ill.		
Cincinnati, Hamilton & Dayton Ry.	2	1,038
J. W. Anderson, Chillicothe, O.		
I. F. White, Dayton, O.		
Cincinnati Northern R. R.	1	236
J. M. Wilkinson, Van Wert, O.		
Colorado & Southern Ry.	2	1,250
Harry James, Denver, Col.		
W. T. Powell, Denver, Col.		
Colorado Springs & Cripple Creek Dist. Ry. etc.	1	160
B. A. Briggs, Cripple Creek, Col.		
Columbia, Newberry & Laurens R. R.	1	75
A. P. Rice, Columbia, S. C.		
Denver, Enid & Gulf R. R.	1	120
D. Lacy, Enid, Okla.		
Duluth & Iron Range R. R.	2	168
W. A. Clark, Duluth, Minn.		
B. T. McIver, Two Harbors, Minn.		
Duluth, Missabe & Northern Ry.	1	275
W. A. McGonagle, Duluth, Minn.		
Duluth, South Shore & Atlantic Ry.	1	586
W. M. Noon, Marquette, Mich.		
Elgin, Joliet & Eastern Ry.	3	770
G. H. Jennings, Joliet, Ill.		
A. Montzheimer, Joliet, Ill.		
C. Thompson, Gary, Ind.		
El Paso & Southwestern System	1	903
Bailey J. Mustain, El Paso, Tex.		
Erie R. R. (and Chicago & Erie)	4	2,499
W. O. Eggleston, Huntington, Ind.		
Fred A. Knapp, Jersey City, N. J.		
Neil McLean, Huntington, Ind.		
W. H. Wilkinson, Elmira, N. Y.		
Florida East Coast Ry.	1	680
E. K. Barrett, St. Augustine, Fla.		

Name of Road and Membership.	Members.	Mileage.
Fort Smith & Western Ry.	1	217
B. F. Beckman, Ft. Smith, Ark.		
Galveston, Harrisburg & San Antonio Ry. and Texas & New Orleans R. R.	1	1,800
C. A. Thanheiser, Houston, Tex.		
Gila Valley, Globe & Northern Ry.	1	125
C. C. Mallard, Globe, Ariz.		
Grand Rapids & Indiana Ry.	2	592
W. S. McKeel, Grand Rapids, Mich.		
H. M. Large, Ft. Wayne, Ind.		
Grand Trunk Ry. System	2	4,645
A. Findley, Montreal, P. Q.		
George A. Mitchell, Toronto, Ont.		
Grand Trunk Pacific Ry.	1	2,440
K. J. C. Zinck, Winnipeg, Man.		
Great Northern Ry.	1	6,976
James E. Nelson, Sioux City, Ia.		
Gulf, Colorado and Santa Fé Ry.	1	1,518
E. C. George, Beaumont, Tex.		
Illinois Central R. R.	10	4,567
P. Aagaard, Chicago, Ill.		
C. C. Bean, Freeport, Ill.		
F. O. Draper, Chicago, Ill.		
T. J. Fullem, Chicago, Ill.		
R. J. McKee, Carbondale, Ill.		
Samuel P. Munson, Mattoon, Ill.		
William Reed, Jr., Vandalia, Ill.		
C. E. Thomas, Chicago, Ill.		
F. L. Thompson, Chicago, Ill.		
E. F. Wise (retired), Waterloo, Ia.		
Illinois Traction System	1	438
G. A. Wright, Decatur, Ill.		
Intercolonial Ry.	8	1,449
T. C. Burpee, Moncton, N. B.		
John Forbes, Halifax, N. S.		
Hugh Jardine, Moncton, N. B.		
A. E. Killam, Moncton, N. B.		
H. J. McGrath, Moncton, N. B.		
W. B. McKenzie, Moncton, N. B.		
Thomas Sefton, Moncton, N. B.		
A. C. Selig, Moncton, N. B.		
International & Great Northern Ry.	1	1,106
H. M. Jack, Palestine, Tex.		
Kansas City, Clinton & Springfield Ry.	1	155
J. B. Brown, Clinton, Mo.		

Name of Road and Membership.	Members.	Mileage.
Lake Erie & Western Ry.	1	882
J. N. Penwell, Tipton, Ind.		
Lake Shore & Michigan Southern Ry.	4	1,529
Willard Beahan, Cleveland, O.		
Philip O'Neill, Adrian, Mich.		
R. H. Reid, Cleveland, O.		
J. L. Soisson, Norwalk, O.		
Lake Superior & Ishpeming Ry., Munising Ry., and Marquette & S. E. Ry.	2	160
August Anderson, Marquette, Mich.		
Roscoe C. Young, Marquette, Mich.		
Lehigh & Hudson River Railway	2	96
J. E. Barrett, Warwick, N. Y.		
Lewis A. Riley, Warwick, N. Y.		
Lehigh Valley R. R.	7	1,446
E. B. Ashby, New York City.		
W. E. Harwig, Phillipsburg, N. J.		
Peter Hofecker, Sayre, Pa.		
Judson Joslin, Auburn, N. Y.		
David A. Keefe, Athens, Pa.		
F. E. Schall, South Bethlehem, Pa.		
E. R. Wenner, Wilkesbarre, Pa.		
Liberty-White R. R.	1	45
J. T. Burke, McComb, Miss.		
Long Island R. R.	2	392
C. F. Spencer, Jamaica, N. Y.		
C. W. Wright, Jamaica, N. Y.		
Louisville & Nashville R. R.	5	4,400
J. M. Bibb, Birmingham, Ala.		
A. J. Catchot, Ocean Springs, Miss.		
R. O. Elliott, Columbia, Tenn.		
Floyd Ingram, Erin, Tenn.		
A. B. McVay, Evansville, Ind.		
Maine Central R. R.	1	925
P. N. Watson, Brunswick, Me.		
Michigan Central R. R.	5	1,745
S. D. Bailey, Detroit, Mich.		
Charles Carr, Jackson, Minn.		
Thomas Hall, St. Thomas, Ont.		
Henry A. Horning, Jackson, Mich.		
J. T. Webster, St. Thomas, Ont.		
Minneapolis & St. Louis R. R.	1	1,027
Ed. Gagnon, Minneapolis, Minn.		
Minneapolis, St. Paul & Sault Ste. Marie Ry.	3	3,526
A. Amos, Minneapolis, Minn.		
P. Swenson, Minneapolis, Minn.		
G. A. Manthey, Minneapolis, Minn.		

Name of Road and Membership.	Members.	Mileage.
Miss. River & Bonne Terre Ry.	1	46
C. H. Fake, Bonne Terre, Mo.		
Missouri, Kansas & Texas Ry.	2	3,073
F. W. Bailey, Denison, Tex.		
J. G. Gossett, Denison, Tex.		
Missouri Pacific Ry. System (including St. Louis, Iron Mountain & Southern Ry.)	13	6,488
Robert J. Bruce, St. Louis, Mo.		
W. R. Collier, Chester, Ill.		
J. A. Costolo, St. Louis, Mo.		
W. Hausgen, Sedalia, Mo.		
E. P. Hawkins, Ferriday, La.		
U. A. Horn, Osawatomie, Kan.		
John Larson, St. Louis, Mo.		
J. O. Potts, St. Louis, Mo.		
F. B. Scheetz, St. Louis, Mo.		
Wm. Sullivan, Kansas City, Mo.		
F. W. Tanner, St. Louis, Mo.		
L. J. Wackerle, St. Louis, Mo.		
W. B. Wood, Atchison, Kan.		
Nashville, Chattanooga & St. Louis Ry.	1	1,230
I. O. Walker, Paducah, Ky.		
National Rys. of Mexico	1	4,739
Hans Bentele, Mexico City, Mex.		
New Orleans Terminal Co.	1	66
Frank G. Jonah, New Orleans, La.		
New South Wales Government Rys.	1	3,280
James Fraser, Sydney, N. S. W.		
New York Central & Hudson River R. R.	9	2,829
William Kleefeld, Jr., Watertown, N. Y.		
G. J. Klumpp, Rochester, N. Y.		
R. P. Mills, New York City.		
Kemper Peabody, N. Y. City.		
W. A. Pettis, Rochester, N. Y.		
Edward Rykenboer, Rochester, N. Y.		
John Schaffer, Rochester, N. Y.		
H. C. Thompson, Weehawken, N. J.		
E. E. Wilson, New York City.		
New York, New Haven & Hartford R. R.	13	2,044
Grosvenor Aldrich, Readville, Mass.		
J. S. Browne, Providence, R. I.		
Wm. Graham, New Haven, Conn.		
H. H. Kenzie, Taunton, Mass.		
Wm. H. Moore, New Haven, Conn.		
B. P. Phillips, Willimantic, Conn.		
H. W. Phillips (retired), South Braintree, Mass.		
L. H. Porter (retired), Franklin, Mass.		
George A. Rodman, New Haven, Conn.		
George T. Sampson, Boston, Mass.		

Name of Road and Membership.	Members.	Mileage.
New York, New Haven & Hartford R. R. *Continued.*		
W. B. Schuessler, New Haven, Conn.		
D. W. Sharp, New London, Conn.		
J. B. Sheldon, Providence, R. I.		
New York, Ontario & Western R. R.	1	494
J. H. Nuelle, Norwich, N. Y.		
New Zealand Government Rys.	2	2,682
C. H. Biss, Christchurch, N. Z.		
George A. Troup, Wellington, New Zealand.		
Norfolk & Southern Ry.	1	582
Thomas W. Cothran, Greenwood, S. C.		
Northern Electric Ry.	1	130
A. D. Schindler, San Francisco, Cal.		
Northern Pacific Ry.	7	5,733
F. R. Bartles, Fargo, N. D.		
James Hartley, Staples, Minn.		
N. F. Helmers, Minneapolis, Minn.		
F. Ingalls, Jamestown, N. D.		
C. S. McCully, Jamestown, N. D.		
R. E. McFarlane, Duluth, Minn.		
J. C. Taylor, Glendive, Mont.		
North Western Govt. Rys. (India)	1	3,880
D. M. Cookson, Kyankpyu, Burma, India		
Oregon Short Line R. R.	1	1,508
A. H. King, Salt Lake City, Utah.		
Pennsylvania Lines West of Pittsburg	8	2,757
Samuel C. Bowers, Steubenville, O.		
Stanton Bowers, Bradford, O.		
B. F. Gehr, Richmond, Ind.		
C. M. Large, Jamestown, Pa.		
A. F. Miller, Chicago, Ill.		
D. G. Musser, Wellsville, O.		
H. H. Pollock, Carnegie, Pa.		
D. C. Zook, Fort Wayne, Ind.		
Pennsylvania R. R.	6	5,311
M. M. Barton, West Philadelphia, Pa.		
J. A. Blair, Pittsburg, Pa.		
Richard G. Develin, Philadelphia, Pa.		
H. R. Leonard, Philadelphia, Pa.		
Robert McKibbon, Altoona, Pa.		
C. W. Richey, Pittsburg, Pa.		
Pere Marquette R. R.	3	2,336
G. E. Hanks, East Saginaw, Mich.		
A. McNab, Holland, Mich.		
J. E. Toohey, Grand Rapids, Mich.		

Name of Road and Membership.	Members.	Mileage.
Philadelphia & Reading Ry.	4	1,120
Amos H. Beard, Reading, Pa.		
John Foreman (retired), Pottstown, Pa.		
W. W. Perry, Williamsport, Pa.		
E. G. Storck, Philadelphia, Pa.		
Pittsburg & Lake Erie R. R.	2	191
D. L. McKee, McKee's Rocks, Pa.		
G. H. Soles, Pittsburg, Pa.		
Queen & Crescent Route	1	338
E. L. Loftin, Vicksburg, Miss.		
Seaboard Air Line Ry.	11	2,760
W. M. Barker, Scotia, S. C.		
M. F. Cahill, Jacksonville, Fla.		
P. W. Cahill, Tallahassee, Fla.		
B. B. Christy, Tallahassee, Fla.		
W. J. Gooding, Jr., Jacksonville, Fla.		
B. Land, Jr., Jacksonville, Fla.		
W. A. McDearmid, Tallahassee, Fla.		
J. C. Nelson, Portsmouth, Va.		
G. B. Smith, Jacksonville, Fla.		
J. A. Wilson, Woodbine, Fla.		
J. L. Winter, Waldo, Fla.		
St. Joseph & Grand Island Ry.	1	319
O. H. Andrews, St. Joseph, Mo.		
St. Louis, Rocky Mt. & Pac. R. R.	1	106
Alf Brown, Raton, N. M.		
St. Louis Southwestern Ry.	2	1,451
J. S. Berry, Tyler, Tex.		
Wm. Quinn, Tyler, Tex.		
Southern Indiana Ry.	2	351
James Dupree, Crete, Ill.		
J. O. Jewell, Terre Haute, Ind.		
Southern Ry.	10	7,055
D. A. Ballenger, Greenville, S. C.		
James T. Carpenter, Princeton, Ind.		
G. W. Detter, Charleston, S. C.		
W. F. Fraylick, Charleston, S. C.		
J. R. Fowlkes, Columbia, S. C.		
Joseph A. Killian, Jr., Charlotte, N. C.		
J. S. Lemond, Charlotte, N. C.		
D. W. Lum, Washington, D. C.		
J. W. Morgan, Columbia, S. C.		
G. W. Welker, Alexandria, Va.		
Southern Pacific Company	9	6,331
T. W. Bratten, West Oakland, Cal.		
Frank V. Carman, West Oakland, Cal.		
Alex. Fraser, Bakersfield, Cal.		

Name of Road and Membership.	Members.	Mileage.
Southern Pacific Company *Continued.*		
James Gratto, Los Angeles, Cal.		
P. N. Nelson, San Francisco, Cal.		
H. Pollard, San Francisco, Cal.		
George W. Rear, San Francisco, Cal.		
Daniel Robertson, West Oakland, Cal.		
L. D. Smith, Oakland, Cal.		
Tennessee Central R. R.	1	326
E. M. Carter, Nashville, Tenn.		
Texas & Gulf Ry.	1	97
K. S. Hull, Longview, Tex.		
Texas & Pacific Ry.	1	1,885
E. Loughery, Marshall, Tex.		
Texas Midland R. R.	1	125
E. H. R. Green, Terrell, Tex.		
Toledo, Peoria & Western Ry.	1	248
J. H. Markley, Peoria, Ill.		
Union Pacific R. R.	2	3,325
J. L. Neff, Omaha, Neb.		
J. Parks, Denver, Col.		
Vandalia R. R.	1	829
J. L. McKee, Spencer, Ind.		
Wabash R. R.	2	2,514
A. O. Cunningham, St. Louis, Mo.		
William S. Danes, Peru, Ind.		
Washington Terminal Co.	2	53
W. M. Cardwell, Washington, D. C.		
C. H. Spencer, Washington, D. C.		
Wellington & Manawata Ry. (New Zealand)	1	84
Arthur Williams, Wellington, New Zealand.		
Western Australia Government Rys.	2	1,540
W. J. George, Perth, Western Australia.		
E. S. Hume, Fremantle, Western Australia.		
Wheeling & Lake Erie R. R.	2	442
Wm. Mahan, Canton, O.		
W. L. Rohbock, Cleveland, O.		
Yazoo & Miss. Valley R. R.	2	1,370
D. H. Holdridge, Vicksburg, Miss.		
W. Shropshire, Greenville, Miss.		
Other members not connected with roads	52	
Total number of members	393	
Total mileage represented		204,570

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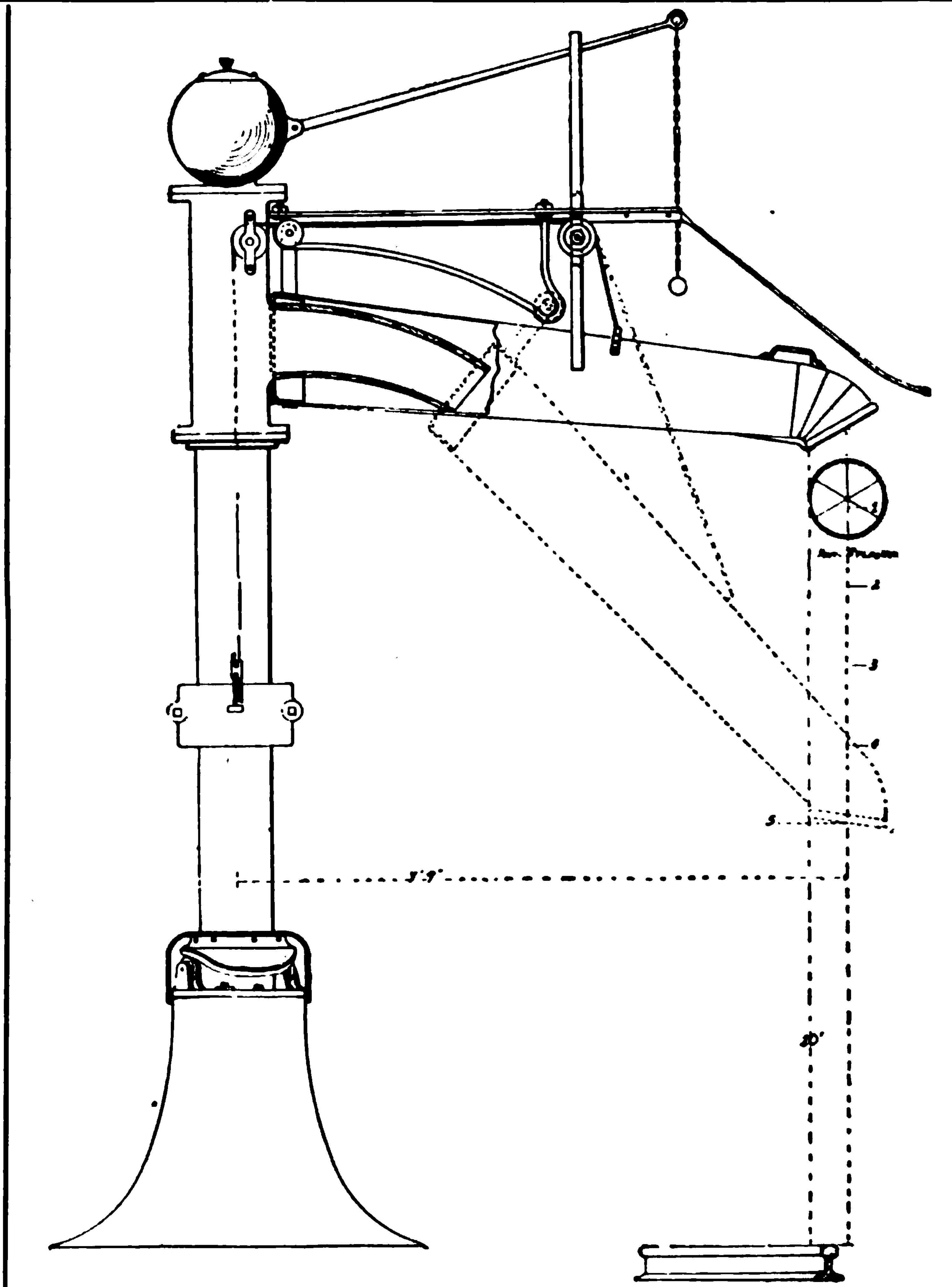

AIR AND ELECTRIC PORTABLE HOISTS

PROCEEDINGS OF THE

Twentieth Annual Convention

OF THE

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION

Successor to the

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS

HELD AT

DENVER, COLORADO

OCTOBER 18-20, 1910

Official Badge

BRETHREN PUBLISHING HOUSE
ELGIN, ILLINOIS
1911

President, 1910-11

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Intercolonial Ry. of Canada, Moncton, N. B.

J. N. Penwell, ... Third Vice-President
Lake Erie & Western Ry., Tipton, Ind.

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G. W. Rear, ... San Francisco, Cal.
Southern Pacific Co.

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Erie R. R.

W. F. Steffens, ... Boston, Mass.
Boston & Albany R. R.

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Duluth, Missabe & Northern Railway.

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*WALTER G. BERG, ...New York City, N. Y.
Lehigh Valley Railroad.

J. H. CUMMIN, ...Bay Shore, N. Y.

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Chicago & Eastern Illinois Railroad.

WALTER A. ROGERS, ...355 Dearborn St., Chicago, Ill.

WILLIAM S. DANES, ...Peru, Ind.
Wabash Railroad.

B. F. PICKERING, ...Salem, Mass.
Boston & Maine Railroad.

ARTHUR MONTZHEIMER, ...Joliet, Ill.
Elgin, Joliet & Eastern Railway.

C. A. LICHTY, ...Chicago, Ill.
Chicago & North Western Railway.

J. B. SHELDON, ...Providence, R. I.
New York, New Haven & Hartford Railroad.

J. H. MARKLEY, ...Peoria, Ill.
Toledo, Peoria & Western Railway.

R. H. REID, ...Cleveland, Ohio
Lake Shore & Michigan Southern Railway.

J. P. CANTY, ...Fitchburg, Mass.
Boston & Maine Railroad.

J. S. LEMOND, ...Charlotte, N. C.
Southern Ry.

*_Deceased._

COMMITTEES FOR 1911

SUBJECTS.

1. Fireproofing Frame and Pile Trestles.

Lee Jutton, C. & N. W. Ry., Chicago, Chairman.
W. H. Moore, N. Y. N. H. & H. R. R., New Haven, Conn.
R. J. Arey, A. T. & S. F. Ry., Los Angeles, Cal.
J. C. Nelson, S. A. L. Ry., Portsmouth, Va.

2. Derricks and Other Appliances for Handling Material in Supply Yards.

J. N. Penwell, L. E. & W. R. R., Tipton, Ind.
A. S. Markley, C. & E. I. R. R., Danville, Ill.
A. Yappen, C. M. & St. P. Ry., Chicago.
A. J. Colwell, C. & N. W. Ry., Norfolk, Neb.
D. B. Taylor, B. & O. R. R., Garrett, Ind.

3. Best Method of Numbering Bridges.

I. F. Stern, C. & N. W. Ry., Chicago.
E. B. Ashby, L. V. R. R., New York City.
W. H. Wilkinson, Erie R. R., Elmira, N. Y.
C. N. Monsarrat, C. P. Ry., Montreal, Que.
Wm. Graham, N. Y. N. H. & H. R. R., New Haven, Conn.
R. H. Reid, L. S. & M. S. Ry., Cleveland, O.

4. Arrangement of Depot and Platforms for Small Towns, as to Convenience and Appearance.

C. H. Fake, M. R. & B. T. R. R., Bonne Terre, Mo.
N. H. LaFountain, C. M. & St. P. Ry., Chicago.
H. M. Jack, I. & G. N. R. R., Palestine, Tex.
O. H. Andrews, St. J. & G. I. Ry., St. Joseph, Mo.
B F. Beckman, Ft. S. & W. R. R., Ft. Smith, Ark.
R J. Bruce, Mo. Pac. Ry., St. Louis, Mo.

5. Sash,—Size and Kind of Glass for Roundhouses and Shops.

A. A. Wolf, C. M. & St. P. Ry., Milwaukee, Wis.
H. Bender, C. & N. W. Ry., Eagle Grove, Ia.
H. A. Horning, M. C. R. R., Jackson, Mich.
C. J. Scribner, Mo. Pac. Ry., St. Louis, Mo.
J. H. Markley, T. P. & W. Ry., Peoria, Ill.
D. C. Zook, Pa. Lines, Ft. Wayne, Ind.

6. Best and Most Economical Pumping Engines.

C. E. Thomas, I. C. R. R., Chicago.
J. Dupree, C. T. H. & S. E. Ry., Crete, Ill.
G. H. Jennings, E. J. & E. Ry., Joliet, Ill.
R. A. Luker, G. C. & S. F. Ry., Silsbee, Tex.
J. B. White, C. & N. W. Ry., Boone, Ia.

7. Records of Bridges, Buildings and Other Structures from time of Construction; Original Cost, and Maintenance.

W. F. Steffens, B. & A. R. R., Boston.
K. Peabody, N. Y. C. & H. R. R. R., New York City.
G. W. Andrews, B. & O. R. R., Baltimore, Md.
A. B. Hubbard, B. & M. R. R., Boston.
J. S. Browne, N. Y. N. H. & H. R. R., Providence, R. I.
F. C. Rand, B. & M. R. R., Boston.

8. Concrete Tank Construction.

F. E. Weise, C. M. & St. P. Ry., Chicago.
G. H. Soles, P. & L. E. Ry., Pittsburg, Pa.
C. W. Richey, P. R. R., Pittsburg, Pa.
W. H. Vance, L. & A. Ry., Stamps, Ark.
D. G. Musser, Penn. Lines, Wellsville, O.

9. Brick Veneer for Station Buildings.

M. E. Gumphrey, C. R. I. & P. Ry., Eldon, Mo.
J. D. Moen, C. & N. W. Ry., Boone, Ia.
W. Beahan, L. S. & M. S. Ry., Cleveland, O.
R. O. Elliott, L. & N. R. R., Columbia, Tenn.
W. A. Conkling, U. P. R. R., Omaha, Neb.

10. Roofs, and Roof Coverings.

T. J. Fullem, I. C. R. R., Chicago.
G. W. Andrews, B. & O. R. R., Baltimore, Md.
C. W. Richey, P. R. R., E. Liberty, Pa.
E. N. Layfield, B. & O. C. T. R. R., Chicago.
J. P. Snow, B. & M. R. R., Boston.
C. A. Marcy, C. & N. W. Ry., Chicago.
J. H. Nuelle, N. Y. O. & W. R. R., Norwich, N. Y.
H. H. Kinzie, N. Y. N. H. & H. R. R., Taunton, Mass.
H. H. Eggleston, C. & A. R. R., Bloomington, Ill.
O. F. Barnes, Erie R. R., Susquehanna, Pa.

11. Embankment Protection.

E. L. Loftin, Q. & C. Ry., Vicksburg, Miss.
P. W. Cahill, S. A. L. Ry., Fernandina, Fla.
C. H. Eggers, C. R. I. & P. Ry., Little Rock, Ark.
J. M. Mann, F. W. & D. C. Ry., Ft. Worth, Tex.
W. G. Massenburg, G. C. & S. F. Ry., Beaumont, Tex.
C. F. Green, Sou. Pac. Co., Sacramento, Cal.
C. S. Thompson, D. & R. G. R. R., Denver, Col.

NOMINATIONS.

R. H. Reid, L. S. & M. S. Ry., Cleveland, O.
J. F. Parker, A. T. & S. F. Ry., San Bernardino, Cal.
S. F. Patterson, B. & M. R. R., Concord, N. H.
A. Montzheimer, E. J. & E. Ry., Joliet, Ill.
J. H. Markley, T. P. & W. Ry., Peoria, Ill.

PUBLICATIONS.

T. L. D. Hadwen, C. M. & St. P. Ry., Chicago.
A. Montzheimer, E. J. & E. Ry., Joliet, Ill.
A. R. Shedd, C. & N. W. Ry., Chicago.

RELIEF.

A. Montzheimer, E. J. & E. Ry., Joliet, Ill.

MEMBERSHIP.

A. H. King, O. S. L. Ry., Salt Lake City.
J. A. Killian, Sou. Ry., Charlotte, N. C.
G. W. Rear, Sou. Pac. Co., San Francisco, Cal.
C. J. Scribner, Mo. Pac. Ry., St. Louis.

OBITUARY.

J. N. Penwell, L. E. & W. Ry., Tipton, Ind.

ARRANGEMENTS.

A. O. Cunningham, Wabash R. R., St. Louis.
J. S. Berry, S. L. S. W. Ry., St. Louis.

Proceedings of the Twentieth Annual Convention

OF THE

American Railway Bridge and Building Association

HELD IN THE ALBANY HOTEL

Denver, Colorado, Oct. 18, 19 and 20, 1910

MORNING SESSION.

Tuesday, October 18, 1910.

The twentieth annual convention of the association was called to order at the Albany Hotel, Denver, at 10:15 A. M., by President J. S. Lemond.

Prayer was offered by Mr. J. N. Penwell.

President.—Owing to the inability of the mayor of this city to attend our opening session this morning he is represented by Mr. A. J. Spengel, who will extend to the association the welcome of the City of Denver.

Mr. Spengel.—Mr. President, Ladies and Gentlemen of the American Railway Bridge and Building Association: On behalf of the mayor and the city administration, whom I have the honor to represent, and the entire people of our city and state, it affords me great pleasure to welcome you to this "mile-high" city, and to our Colorado air. I find myself compelled to apologize this morning for our sun. We pride ourselves on our ever shining sun, and she seldom fails us. However, the sun was out this morning if you were out early enough to see it, and the only thing that could have caused it to retire was the beauty and intelligence that confronted it this morning when this convention assembled.

You are railroad men and women, and as such I want personally to give you welcome. To a certain extent, I am also in that business and perhaps more than ever can feel and appreciate the work of an able and intelligent, and conscientious

railroad man and employee. I do not know that there is a single branch of the railroad work which requires so much intelligence as does the work of the man at the top and the man under him, who have the important work, perhaps the most important work, under his hands, the bridges. We can build beautiful roads in our country, we can lay out the most magnificent parks, with the utmost care, but we all meet with an obstruction when we come to a chasm that cannot be crossed unless you gentlemen come to the rescue, and you are doing it. The progress that has been made in your branch is wonderful, and the bridges that are being constructed, to a layman, sometimes look impossible.

In talking about railroads, if you will pardon the digression, I would like to tell a story I heard the other day which appealed to me as very applicable to the railroads, so much so that I am going to give it, as I believe you people can thoroughly appreciate it.

Tim Sullivan started in on the section, and wielded the pick and the shovel, and so well did he do it that he soon became the section foreman. From there it was but a step to roadmaster, and so on up till he became superintendent of the line. Of course it took years to accomplish that, but hard work and close attention to business brought its reward, step by step. The family that he raised tried to keep up with his promotions, and when he became superintendent, they tried to forget that Tim was ever on the section. That subject was forgotten and tabooed. In due course of time Tim went the way of all of us, home to his Father, and on the morning of the funeral the wife, resting on the arm of the eldest daughter, went into the room where Tim lay, to take a last look at the remains. She viewed the various floral tributes from the different section gangs and different officers, and said to the daughter, as she looked at one particular piece, "Biddy, what is that?" and she replied that it was the dove of peace. Looking at another she made the same query, and Biddy replied that it was a pillow, and the inscription read "Rest in Peace." Glancing about the room she saw in the window a beautiful anchor, and instantly exclaimed, "Biddy! Biddy! who the Divvle sint the pick?" (Applause).

Ladies and Gentlemen, you have come to the playground of America, and we want you to appreciate it to the full. We know you have come on business, but you know that "all work and

no play makes Jack a dull boy," and I take it that you have not come for all work, but some play, as I see that a considerable number of the wives are present.

I do not bring the keys of the city with me, for we have no keys in the West. The latch string hangs ever on the outside; pull it freely. You will find a welcome behind every door, and if any of you gentlemen find that the altitude affects you, with your heavy work, and night sessions, the mayor was particular to inform me that he has vehicles at the city hall that will answer every call (Applause).

And now, may you be successful in all your undertakings. May your work be of benefit to each and every one of you, and it will be of benefit to the country and to mankind, because an aggregation such as this cannot help but be of benefit to the railroads with whom you are employed; and when it becomes a benefit to them it will become a benefit to all people. I bid you Godspeed in your work. We are glad to have you with us, and we hope to make such an impression that you will want to come again. I thank you. (Applause).

President.—Mr. M. F. Cahill will respond to the address of welcome.

Mr. Cahill.—Mr. President, Mr. Speaker, Ladies and Gentlemen: It gives me pleasure to be appointed the spokesman of the association to accept the welcome of this gentlemen from Denver, but I want to take issue with him right here. He says they have no keys in Denver. We met last year in Jacksonville. There we had one key, and that was to the police station. The mayor locked up all the policemen and then gave us the key. Now the first thing I saw when I went out the door this morning was two policemen standing there watching. (Applause).

Again he states they are short of sunshine. We from the South make sunshine. We bring it with us; we have it all the time; we bring it in our hearts, in our manner and in our work.

Again I must take issue with him when he says we are the bridge builders of the United States. What a measly little place that is! We are not the bridge builders of the United States, we are the bridge builders of the world. Our association includes members from 7 foreign countries. We occupy a unique position. We are rarely ever seen, and seldom heard, except on an occasion of this kind. We do things because we have to; you all know that (Applause).

Now in regard to the ladies: It is asserted some place in the Bible, " Man, know thyself." Some of us know ourselves, for we have brought our wives with us (Applause). Some of us were old bachelors at the last convention, but have taken warning and are now married; some of us have lost our partners, but have married again.

We thank you, Mr. Speaker, for your welcome to this beautiful city. This is not my first time here, and I hope it will not be my last, and if these ladies and gentlemen like sunshine, they will come again. We accept your hospitality, and hope we will go away sober (Applause).

President.—The next thing in order is an address by Mr. J. D. Milliken, General Counsel for the Denver, Laramie & Northwestern R. R.

Mr. Lichty.—Mr. Milliken has found it impossible to be in attendance, but has sent a letter which reads as follows:

I am disappointed that at almost the last moment I am called from the city on business of great importance, which deprives me of the pleasure of meeting with you and filling my place on the program as best I could, pursuant to your kind invitation. The loss, however, is largely mine, for I expected to be greatly edified as well as entertained by the able discussions which I know will be had at your convention. There is no class of scientific men for whom I have a higher regard than the men who operate in the field of mechanical and mathematical science. Your responsibilities are very great, and the field for the exercise of your versatile talents is a broad one.

I have neither a scientific or practical knowledge of bridge building. In fact I know but little of the subject. I have heard the society ladies of my acquaintance talk much about "bridge," but it is an enigma to me. I have oft-times stood at the "Bridge of Sighs," but fearing that it was not the kind of bridge that would "carry me safely over," I have never ventured to cross. I have also read in the Koran of the bridge uniting this perplexing, but glorious, old world with the Great Beyond; and also as a citizen of Denver, have heard of the Fourteenth Street Viaduct, which I judge, from the newspaper discussion in the past, is one of the most important bridges of history. However, this is largely the extent of my knowledge of the important subject which you have convened to discuss. I know that your meeting will be one of great profit and pleasure, and I can only hope that your sojourn in our beautiful city will be a pleasant one, and I heartily join in the cordial welcome which our distinguished citizen, Mr. A. J. Spengel, who is a business associate of mine, accords you.

Respectfully,

(Signed) John D. Milliken.

President.—Next in order is roll call, which is handled by a system of registration. Each member is requested to fill out a card provided for that purpose which may be found on the table near the entrance. The registration showed the following members present:

Members Present.

Aagaard, P., Supvr. B. & B., I. C. R. R., Chicago.
Aldrich, G., Supvr. B. & B., N. Y. N. H. & H. R. R., Readville, Mass.
Ashby, E. B., Chief Engr., L V. R. R., New York City
Ballenger, D. A., Roadmaster, Sou. Ry., Greenville, S. C.
Beard, A. H., For. Carp., P. & R. Ry., Reading, Pa.
Bender, H., For. B. & B., C. & N. W. Ry., Eagle Grove, Ia.
Bibb, J. M., Supvr. B. & B., L. & N. R. R., Birmingham, Ala.
Bratten, T. W., Supvr. B. & B., S. P. Co., Oakland, Cal.
Briggs, B. A., Supt. Streets, Colorado Springs, Colo.
Brown, Alf., Supt. B. & B., St. L. R. M. & P. R. R. Ry., Raton, N. M.
Browne, J. B., Gen. For. B. & B., K. C. C. & S. Ry., Clinton, Mo.
Cahill, M. F., Mast. Carp., S. A. L. Ry., Jacksonville, Fla.
Cardwell, W. M., Mast. Carp., Wash. Term. Co., Washington, D. C.
Clark, W. M., Mast. Carp., B. & O. R. R., Pittsburg, Pa.
Costolo, J. A., Supt. Floating Equip., Mo. Pac. Ry., St. Louis, Mo.
Crane, Henry, Janesville, Wis.
Dupree, Jas., For. W. S., Sou. Ind. Ry., Crete, Ill.
Eggleston, W. O., Br. Inspr., Erie R. R., Huntington, Ind.
Fowlkes, J. R., Roadmaster, Sou. Ry., Columbia, S. C.
Fraser, Alex, Supt. B. & B., Sou. Pac. Ry., Bakersfield, Cal.
Gehr, B. F., Mast. Carp., P. C. C. & St. L. Ry., Richmond, Ind.
George, E. C., Supvr. B. & B., G. C. & S. F. Ry., Beaumont, Tex.
Gratto, J., Supvr. B. & B., Sou. Pac. Co., Los Angeles, Cal.
Griffith, F. M., Supvr. B. & B., C. & O. Ry., Covington, Ky.
Hausgen, W., Supvr. B. & B., Mo. Pac. Ry., Sedalia, Mo.
Hofecker, P., Supvr. B. & B., L. V. R. R., Auburn, N. Y.
Hunciker, Jno., Gen. For., C. & N. W. Ry., Chicago.
Irwin, J. W., Contractor, Chadron, Neb.
James, Harry, Gen. For., C. & S. Ry., Denver, Colo.
Jewell, J. O., Supt. B. & B., Sou. Ind. Ry., Terre Haute, Ind.
Jutton, Lee, Genl. Inspr. of Brs., C. & N. W. Ry., Chicago.
Kelly, C. W., F. M. & Co., Chicago.
Killam, A. E., Inspr. B. & B., I. C. R., Moncton, N. B.
Killian, J. A., Asst. Engr., Sou. Ry., Charlotte, N. C.
King, A. H., Supt. B. & B., O. S. L. Ry., Salt Lake City.
King, C. F., R. M. & For. B. & B., C. & N. W. Ry., Shoshoni, Wyo.
Kinzie, H. H., Supvr. B. & B., N. Y. N. H. & H. R. R., Taunton, Mass.
Large, H. M., Mast. Carp., G. R. & I. Ry., Ft. Wayne, Ind.
Leake, T. S., Genl. Contr., Chicago.
Lemond, J. S., Engr. M. of W., Sou. Ry., Charlotte, N. C.
Lichty, C. A., Genl. Inspr., C. & N. W. Ry., Chicago.
Loftin, E. L., Supvr. B. & B., Q. & C. Ry., Vicksburg, Miss.
Manthey, G. A., Asst. Supt. B. & B., Soo Line, Minneapolis, Minn.
Markley, J. H., Mast. B. & B., T. P. & W. Ry., Peoria, Ill.
McKee, D. L., Gen. For. B. & B., P. & L. E. Ry., McKee's Rocks, Pa.
McKeel, W. S., Mast. Carp., G. R. & I. Ry., Grand Rapids, Mich.
McLean, Neil, Mast. Carp., Erie R. R., Huntington, Ind.
McNab, A., Supvr. B. & B., P. M. R. R., Holland, Mich.
Meyers, W. F., For. B. & B., C. & N. W. Ry., Belle Plaine, Ia.
Miller, A. F., Mast. Carp., Pa. Lines West, Chicago.
Mills, R. P., Supvr. Bldgs., N. Y. C. & H. R. R. R., New York City
Moen, J. D., For. B. & B., C. & N. W. Ry., Boone, Ia.
Moore, W. H., Engr. Brs., N. Y. N. H. & H. R. R., New Haven, Conn.
Morgan, J. W., Supvr. B. & B., Sou. Ry., Columbia, S. C.
Morrill, H. P., C. & N. W. Ry., Madison, Wis.
Musser, D. G., Pa. Lines West, Wellsville, Ohio.
Mustain, B. J., Sup. W. S., E. P. & S. W. Ry., Eichel, N. M.
Nelson, O. T., Roadmaster, A. & W. P. Ry., Montgomery, Ala.
Noon, W. M., Supt. B. & B., D. S. S. & A. Ry., Marquette, Mich.
Nuelle, J. H., Asst. Engr., N. Y. O. & W. Ry., Norwich, N. Y.

PARKER, J. F., Gen. For. B. & B., A. T. & S. F. Ry., San Bernardino, Cal.
PARKS, JAS., Supvr. B. & B., U. P. R. R., Denver, Colo.
PATTERSON, S. F., Gen. For. B. & B., B. & M. R. R., Concord, N. H.
PENWELL, J. N., Supvr. B. & B., L. E. & W. R. R., Tipton, Ind.
PERRY, W. W., Mast. Carp., P. & R. Ry., Williamsport, Pa.
POWELL, C. E., Supvr. B. & B., C. & O. Ry., Hinton, W. Va.
POWELL, W. T., Supt. B. & B., C. & S. Ry., Denver, Colo.
REAR, GEO. W., Gen. Br. Inspr., Sou. Pac. Co., San Francisco, Cal.
RETTINGHOUSE, H., Div. Engr., C. & N. W. Ry., Boone, Ia.
RICE, A. P., Roadmaster, C. N. & L. R. R., Columbia, S. C.
SCHALL, F. E., Br. Engr., L. V. R. R., So. Bethlehem, Pa.
SHARPE, D. W., Supvr. B. & B., N. Y. N. H. & H. R. R., New Haven, Conn.
SHEDD, A. R., Asst. Genl. Bridge Inspector, C. & N. W. Ry., Chicago.
SHOPE, D. A., Gen. For. B. & B., A. T. & S. F. Ry., Fresno, Cal.
SMITH, L. D., Struct. Engr., Sou. Pac. Co., San Francisco, Cal.
SPENCER, WM., Gen. For. B. & B., C. & N. W. Ry., Chadron, Nebr.
STANNARD, JAS., Contractor, Kansas City, Mo.
STATEN, J. M., Gen. Inspr. Brs., C. & O. Ry., Richmond, Va.
STORCK, E. G., Mast. Carp., P. & R. Ry., Philadelphia.
SWEENEY, WM., For. B. & B., C. & N. W. Ry., Green Bay, Wis.
TALBOTT, J. L., Gen. For., A. T. & S. F. Ry., Pueblo, Colo.
TAYLOR, D. B., Mast. Carp., B. & O. R. R., Garrett, Ind.
TAYLOR, F. A., Mast. Carp., B. & O. R. R., Cumberland, Md.
THOMAS, C. E., Gen. For. W. W., I. C. R. R., Chicago.
VANDERGRIFT, C. W., Supvr. B. & B., C. & O. Ry., Ronceverte, W. Va.
WEISE, F. E., Ch. Clk., B. & B., C. M. & St. P. Ry., Chicago.
WELLS, J. M., G. F. B. & B., A. T. & S. F. Ry., Chillicothe, Ill.
WENNER, E. R., Supvr. B. & B., L. V. R. R., Ashley, Pa.
WINTER, J. L., Mast. Carp., S. A. L. Ry., Waldo, Fla.
WISE, E. F., Waterloo, Iowa.
WOLF, A. A., Dist. Carp., C. M. & St. P. Ry., Milwaukee.
YAPPEN, A., Dist. Carp., C. M. & St. P. Ry., Chicago.
YOUNG, R. C., Ch. Engr., L. S. & I. Ry., Marquette, Mich.
ZOOK, D. C., Mast. Carp., Penn. Lines West, Ft. Wayne, Ind.

The following applicants for membership, subsequently elected, were also present:

BEESON, R. W., For. B. & B., C. & S. Ry., Trinidad, Colo.
BURKE, D., Supvr. B. & B., Sou. Pac. Co., Tucson, Ariz.
CONKLING, W. A., Supvr. B. & B., U. P. R. R., Omaha.
FELLOWS, C. W., For. W. S., C. & S. Ry., Denver, Colo.
FLETCHER, JR., J. W., Roadmaster, Car. & N. W. Ry., Chester, S. C.
GREEN, C. F., Supvr. B. & B., Sou. Pac. Co., Sacramento, Cal.
GUILD E. Supvr. B. & B., P. M. R. R., Grand Ledge, Mich.
GUMPHREY, M. E., Mast. Carp., C. R. I. & P. Ry., Eldon, Mo.
LUKER, R. A., Supvr. W. S., G. C. & S. F. Ry., Silsbee, Tex.
MANN, J. M., Gen. For. B. & B., Ft. W. & D. C. Ry., Ft. Worth, Tex.
MASSENBURG, W. G., Div. Engr., G. C. & S. F. Ry., Beaumont, Tex.
MATTHEWS, W. H., Mast. Carp., Erie R. R., Hornell, N. Y.
PAUBA, A. W., For. B. & B., C. & S. Ry., Denver, Colo.
RIDGWAY, A. O., Asst. Ch. Engr., D. & R. G. R. R., Denver, Colo.
SCRIBNER, C. J., Bldg. Inspr., Mo. Pac. Ry., St. Louis, Mo.
TAYLOR, H., Supvr. B. & B., D. & R. G. R. R., Alamosa, Colo.
THOMPSON, C. S., Supt. B. & B., D. & R. G. R. R., Denver, Colo.
VAUGHAN, JAS., Supvr. B. & B., D. & R. G. R. R.. Salida, Colo.
WARE, B. C., Mast. Carp., C. R. I. & P. Ry., Dalhart, Tex.
WEHLEN, CHAS., Br. Inspr., L. I. R. R., Jamaica, N. Y.
WICKS, WARREN, Gen. For., L. I. R. R., Amityville, N. Y.
WILSON, W. W., Div. Engr., G. C. & S. F. Ry., Galveston, Tex.
WOOD, J. W., Gen. For. A. T. & S. F. Ry., Needles, Cal.

Total number of members present, 117.

President.—The next in order is the reading of the minutes of the last meeting.

Motion made to dispense with the reading.

Motion carried.

THE PRESIDENT'S ADDRESS.

Ladies and Gentlemen:—The next thing in order is an address by the president, but as I am not a public speaker, or accustomed to addressing audiences of this kind, you must not expect much.

This is the second time in the history of this association that it has been the pleasure of its members to meet in this beautiful City of Denver, nestled, as it is, among the snow-capped mountains of Colorado. We have heard a great many complimentary remarks, from the older members of this association who were fortunate enough to be present, about the beneficial meeting that convened here thirteen years ago tomorrow, and we hope to have a much better one this year. It has been stated that the railroads in this section have progressed very much during the last decade. The difficult construction of many of them, some of which we hope to see, is of world-wide notoriety. Observation of these, as well as of those over which we have traveled in coming here and on which we will return to our homes, will be greatly beneficial. But we expect to reap even greater advantages from mingling with the members of this association who are located in this section and in the far west who have not been with us in our meetings that have been held in the cities farther east during the past ten years. We hope in the discussion of the various subjects, to get their ideas, and as they are accustomed to handling difficult work, we know we will be benefited thereby.

I wish to state that the membership of the association has increased very rapidly during the past few years. Last year we took in 37 new members and this year we have 56 applications, which gives us a total membership of 428.

In the past we were accustomed to mention the railroad mileage covered by members of this association, but it has now become so broad that it is only necessary to ascertain the total railroad mileage in the United States and fifty per cent of that of Canada, Mexico, Australia, New Zealand and India and you have practically the mileage covered by the membership of this association.

In its infancy, it, like most other similar associations, began with a small membership, but it has grown until it is now like the backwoodsman's train. He heard that a railroad had been built into a certain town, some forty or fifty miles from his home, and declared he did not believe it, but said that he would find out. So he called his two boys and instructed them to have his two faithful oxen, "Buck" and "Ball," ready to start at sunrise the following morning. Accordingly, they set out across the mountains and valleys, traveling by day and camping at night. They traveled in this manner for three days, and when they arrived at their destination they learned that the road was actually there and the train had arrived and the engine had been put away for the night, but would leave early the next morning. So they were up early and went to see it. When they reached the vicinity of the station the train was made up ready for the trip. They viewed it from quite a distance, at first, but finally grew bolder and got very near to it. The old gentleman scrutinized it very carefully and asked a great many questions, and when he was told that it was to pull the string of cars coupled to it, he was very emphatic in his declaration, that it would never do it. "Why," said he, "Buck and Ball could not even move them, much less that little engine." But by and by the time for departure arrived, and the engineer climbed aboard and

gave it steam, and the engine began to throb and the wheels began to turn; slowly at first, but gradually increasing until a speed of twenty-five or thirty miles an hour was reached. About the time it turned a curve, half a mile away, which gave a fine broadside view of it, he turned to those assembled and remarked: "It did start it, but, by Jemminie, they will never stop it." That is the way of this association: it moved slowly at first, but it has now attained such a speed that it will never stop. You hear its merits extolled in gatherings of bridge men wherever they meet, and quite a number of libraries have the proceedings on file for the instruction of the patrons, and our records are taken as authority on the great work of maintaining bridges and buildings. Speaking in a prophetic way, I look forward to a very bright future for the association. It is brighter today than at any time in its history.

Before concluding, I want to say a few words relative to the originators of this association. Realizing the need of such an association a few faithful, intelligent, energetic superintendents of bridges and buildings who had the foresight of the good to be realized from such an organization, met in a little room at St. Louis nineteen years ago and organized, and, without detracting anything from these estimable gentlemen, I dare say they did not foresee how well they were sowing, nor did they expect to reap such a harvest as is being reaped. Some of them have passed to their reward and it can be well said: "Thy good, faithful and intelligent services entitle thee to a peaceful rest."

I fear we did not let those who have gone know how much we appreciated them and their work, but it is not too late for us to show our appreciation to the few faithful ones yet among us, and I am going to request you to give them a rising vote of thanks. I thank you for your kind attention.

President.—The ladies will now be permitted to retire. We will next have the report of the executive committee.

REPORT OF EXECUTIVE COMMITTEE.

A session of the executive committee was called by President Lemond at the close of the Jacksonville convention last year.

The secretary was instructed to order a solid gold badge each year hereafter for the president of the association, and he be allowed to retain it.

The matter pertaining to the number of copies of the proceedings to be published, and their distribution was left to the discretion of the secretary.

Mr. W. M. Camp was chosen as editor for the proceedings to act in conjunction with the secretary and the publication committee.

It was voted that the secretary emeritus, Mr. S. F. Patterson, be allowed his expenses in attending future meetings.

It was decided that badges for members of families (other than wives) be given out at the beginning of conventions upon application of a member who will be held responsible for the return of such badges at the close of each convention.

The assistant secretary was voted $100 for his services during the year 1909.

An executive committee meeting was called to order by President J. S. Lemond at the Auditorium Hotel, March 16, 1910. The only matter of business brought up at that time was the advisability of holding the 1910 convention at Fort Worth as had been voted at the Jacksonville convention. The vote resulted in the affirmative. Later in the year it was learned that the Texas State fair was to be held at Dallas, (30 miles distant) at the same time, and that in as much as many people flocked to Fort Worth for hotel accommodations it was not possible to make satisfactory arrangements for taking care of our party and the committee thereupon, after careful deliberation, decided to hold the convention at Denver.

A special meeting was called to order by President Lemond at the

Albany Hotel, Tuesday morning, Oct. 18, 1910, when matters pertaining to the entertainment features of the Denver convention were brought up and discussed.

C. A. Lichty,
Secretary.

President.—The next thing in order is the reading of the report of the secretary.

SECRETARY'S REPORT.

The association is in a growing and prosperous condition, having increased in numbers during the past ten years from 171 to over 400. Our membership now reaches out into Canada, Mexico, Australia, New Zealand, China, India, Cuba, Panama and the Philippines. Our reports are being furnished to the leading technical societies, libraries and universities at home and abroad.

We have received letters of regret from many of our best and oldest members who are unable, for various reasons, to be with us at this meeting, but we have their expressions of brotherly love urging us on to the good work which is before us.

We miss the faces of some of our most loyal brothers whom we shall see in these earthly gatherings no more, seven of whom have answered the final summons during the past short year. Their familiar faces and words of cheer will be missed in this and future conventions.

While we do not anticipate that we shall in any way be disappointed with Denver as a meeting place for this our twentieth annual convention, many will, nevertheless, regret having missed the opportunity of visiting the great commonwealth of Texas, which was rightfully entitled to the meeting by the vote of the association at Jacksonville last year, and which might have included us within her borders at this time had not the matter of hotel accommodations been the cause of seeking another location. The splendid attendance here proves conclusively that no error was made in the selection of this city when it was found necessary to make the change. Such changes of location, so late in the season, are, however, as a general rule, not conducive to the best interests of the association, and should not be made except in extreme cases.

Considerable pressure has been brought to bear during the past year relative to the holding of the conventions in cities somewhere near the center of population, and not to go to remote cities two years in succession, but only at intervals of several years. This idea is well worthy of careful and thoughtful consideration.

The secretary has voluntarily undertaken the publication of a little pamphlet called the "Bulletin," two numbers of which were issued during the past year. If it be the pleasure of the association he will be glad to enlarge upon its usefulness and try to make it of service in furnishing news items, etc., as well as a means of issuing notices.

FINANCIAL.

RECEIPTS.

Balance on hand last report	$ 117.14
Fees and dues,	731.00
Advertisements,	1,461.60
Sale of books,	26.95
Advanced by treasurer,	700.00
	$3,036.69

DISBURSEMENTS.

Secretary's convention expenses,	$ 25.80	
Committee expenses,	78.15	
Stenographer,	214.00	
Printing,	910.73	
Postage,	115.24	
Stationery and supplies,	21.20	
Editor,	65.00	
Badges,	57.41	
Treasurer's bond,	7.50	
Salaries,	700.00	
Side trips, Jacksonville convention,	388.25	
Miscellaneous items,	17.64	$2,600.92
Balance on hand,		$ 435.77

Respectfully submitted,
C. A. Lichty,
Secretary.

President.—We will now have the treasurer's report.

TREASURER'S REPORT.

RECEIPTS.

Received from former treasurer, Mr. C. P. Austin, Nov. 19, 1909,	$1,935.49	
Interest to Oct. 1910,	37.06	$1,972.55

DISBURSEMENTS.

Paid to the secretary, Dec. 11, 1909,	700.00
Balance on hand, Oct. 15, 1910,	$1,272.55

J. P. Canty,
Treasurer.

Mr. Stannard.—I move that the reports of the secretary and the treasurer be accepted and referred to the auditing committee, and printed in the proceedings.

Motion duly seconded and carried.

President.—The next in order is the report of the membership committee.

REPORT OF MEMBERSHIP COMMITTEE.

Salt Lake City, Oct. 18, 1910.

The committee sent out about 500 circulars similar in style to those of last year which resulted in 56 applications having been received from various parts of the country the most of which are from the western portion.

The following 56 applicants are respectfully submitted for membership in the association:

Barnes, O. F., Div. Engr., Erie R. R., Susquehanna, Pa.
Beeson, R. W., Div. For. B. & B., C. & S. Ry., Trinidad, Colo.
Bigelow, F. M., Supvr. B. & B., S. P. L. A. & S. L. R. R., Salt Lake City.
Black, J. D. Supvr. B. & B., P. M. R. R., Saginaw, Mich.
Blackwell, J. H., Roadmaster, Sou. Ry., Charleston, S. C.

BURKE, D., Supvr. B. & B., Sou. Pac. Co., Tucson, Ariz.
COLWELL, A. J., Gen. For. B. & B., C. & N. W. Ry., Norfolk, Nebr.
CONKLING, W. A., Supvr. B. & B., U. P. R. R., Omaha.
CORBIN, W. S., For. B. & B., Sou. Pac. Co., Los Angeles.
DE CAPITO, T. F., Gen. For. B. & B., Q. O. & K. C. R. R., Milan, Mo.
EGGERS, C. H, Mast. Carp., C. R. I. & P. Ry., Little Rock, Ark.
FELLOWS, C. W., For. W. S., C. & S. Ry., Denver, Colo.
FERRIS, B. F., For. B. & B., Sou. Pac. Co., Los Angeles.
FLETCHER, JR., J. W., Roadmaster, Car. & N. W. Ry., Chester, S. C.
FRASER, NEIL, Genl. Br. For., Sou. Pac. Co., Sacramento, Cal.
FRAZIER, W. C., Supvr. B. & B., S. P. L. A. & S. L. Ry., Los Angeles.
GIESING, AUG., Supt. B. & B., C. R. R. R., Houghton, Mich.
GREEN, C. F., Supvr. B. & B., Sou. Pac. Co., Sacramento, Cal.
GUILD, EDW., Supvr. B. & B., P. M. R. R., Grand Ledge, Mich.
GUMPHREY, M. E., Mast. Carp., C. R. I. & P. Ry., Eldon, Mo.
HORTH, A. J., Mast. Carp., Erie R. R., Meadville, Pa.
LAND, G. W., Supvr. B. & B., St. L. I. M. & S. Ry., Monroe, La.
LUKER, R. A., Supvr. W. S., G. C. & S. F. Ry., Silsbee, Tex.
MANN, J. M., Genl. For. B. & B., Ft. W. & D. C. Ry., Ft. Worth, Tex.
MASSENBURG, W. G., Div. Engr., G. C. & S. F. Ry., Beaumont, Tex.
MATTHEWS, W. H., Mast. Carp., Erie R. R., Hornell, N. Y.
McCAULLEY, S. W., For. B. & B., C. M. & St. P. Ry., Bacon, Wis.
PAUBA, A. W., For. B. & B., C. & S. Ry., Denver, Colo.
PROCTOR, VICTOR, Gen. For. B. & B., A. T. & S. F. Ry., Winslow, Ariz.
RIDGWAY, ARTHUR, Asst. Ch. Engr., D. & R. G. R. R., Denver, Colo.
RINTOUL, D. T., Genl. For. B. & B., Sou. Pac. Co., Bakersfield, Cal.
ROBERTSON, A. A., Supvr. B. & B., N. W. Pac. Ry., San Rafael, Cal.
ROBINSON, JOHN, Supvr. B. & B., P. M. R. R., Grand Rapids, Mich.
SCHENCK, W. S., Mast. Carp., B. & O R. R., Connellsville, Pa.
SCRIBNER, C. J., Bldg. Inspr., Mo. Pac. Ry., St. Louis, Mo.
SHARPE, T. E., Supvr. B. & B., Sou. Ry., Greenville, S. C.
SHEDD, A. R., Asst. Genl. Br. Inspr., C. & N. W. Ry., Chicago.
SHELEY, WM., Asst. Supvr. B. & B., L. & N. R. R., Evansville, Ind.
SIEFER, F. M., Asst. Engr., Sou. Pac. Co., Oakland Pier, Cal.
STUART, T. J., Supvr. B. & B., W. Pac. Ry., Elko, Nev.
SWARTZ, A., Div. Engr., Erie R. R., Huntington, Ind.
TAYLOR, H., Supvr. B. & B., D. & R. G. R. R., Alamosa, Colo.
THOMPSON, C. S., Supt. B. & B., D. & R. G. R. R., Denver,
VANCE, WM. H, Engr. M. of W., La. & Ark. Ry., Stamps, Ark.
VAUGHAN, JAS., Supvr. B. & B., D. & R. G. R. R., Salida, Colo.
VEST, W. E., Asst. Engr., Sou. Ry., Charlotte, N. C.
WAITS, A. L., Br. For., St. L. I. M. & S. Ry., Argenta, Ark.
WARE, B. C., Mast. Carp., C. R. I. & P. Ry., Dalhart, Tex.
WARNE, C. C., Asst. Engr., N. Y. C. & H. R. R. R., New York City.
WEHLEN, CHAS. Br. Inspr., L. I. R. R., Jamaica, N. Y.
WICKS, WARREN, Genl. For., L. I. R. R., Amityville, N. Y.
WILEY, J. G., Supvr. B. & B., Sou. Pac. Co., Dunsmuir, Cal.
WILLIAMS, J. C., Supvr. B. & B., A. & W. P. Ry., Opelika, Ala.
WILSON, M. M., Div. Br. Inspr., Sou. Pac. Co., Los Angeles.
WILSON, W. W., Div. Engr., G. C. & S. F. Ry., Galveston, Tex.
WOOD, J. W., Gen. For. B. & B., A. T. & S. F. Ry., Needles, Cal.

A. H. KING, *Committee.*

Mr. Rettinghouse.—I move that the secretary be instructed to cast one ballot for admittance of new members.

Motion duly seconded and carried and ballot cast by the secretary; the applicants were declared elected, and entitled to all the rights and privileges of the association.

President.—The next in order is the appointment of the committees, which will be as follows:

Subjects: J. H. Markley, E. B. Ashby, G. W. Rear, A. A. Wolf, W. W. Perry.
Resolutions: H. Rettinghouse, James Stannard, J. M. Staten.
Auditing: L. Jutton, G. Aldrich, J. N. Penwell.
Obituary: S. F. Patterson, D. L. McKee, D. C. Zook.

Morning session adjourned at 12 noon.

AFTERNOON SESSION.

Tuesday, Oct. 18, 1910.

Meeting called to order by the president at 2:15 P. M.

President.—The next will be the report of the committee on memoirs.

REPORT OF COMMITTEE ON MEMOIRS.

Once more we are called upon, in our busy lives, to stop and think over the past year. and are reminded that we are here only for a brief time, and then are called to a permanent home. With each day are born new opportunities which fade at its close. It therefore behooves us to improve each hour; to fit ourselves not only for the activities of this life, but for the life to come.

During the past year, six of our members, some of whom were among the best known in our association, have been taken from among us, and are now beyond our praise or censure, in the hands of One more just than we.

The committee begs leave to submit the following memoirs, and recommends that a copy be sent to the families of the deceased friends, and printed in the proceedings of this association.

J. N. Penwell, *Committee.*

MEMOIR.

James D. Gilbert, general foreman of bridges, A. T. & S. F. Ry., elected a member of this association at Denver, in 1897, died November 4, 1909, after a very brief illness.

Mr. Gilbert was born December 15, 1866, at Panora, Iowa. He was educated in the public schools of his native village, and took up railroad work as a section man, at the age of sixteen. Soon after this he entered the bridge and building department as an erector, working with Mr. M. Riney, who is now a member of our association. At the age of twenty he was placed in charge of a pile driver crew, working for the M. K. & T. Ry. and the American Bridge Company. In 1900 he accepted a position with the

JAMES D. GILBERT.

Gulf, Colorado & Santa Fe Ry., as iron bridge foreman, and had charge of the iron construction work on these lines. In 1903, he was transferred to the A. T. & S. F. Ry., and was general iron bridge foreman on a portion of these lines. Besides the regular bridge work, he erected the steel work for the railroad buildings at Clovis, Argentine, La Junta, and Topeka.

Mr. Gilbert was married Oct. 12, 1897, to Miss Minnie Bach, who survives him. He was in failing health during the past four years, but was able to look after his work, personally directing and overseeing the men, to within a few days of his death.

He was a man of splendid personality, very capable and conscientious, with a very enviable record. It was said of him that he was exceedingly popular with his men, as well as with his employers.

MEMOIR.

Holland W. Fletcher, elected a member of this association, at Chicago, in 1896, died at his home in Allegheny City, Pa., April 26, 1910, after four days' illness of pneumonia.

Mr. Fletcher was born at Whiteston, Butler County, Pa., October 14, 1838. He moved with his parents to Allegheny City when about twelve years of age, and attended school at that place until he began his trade as a carpenter. He enlisted in Company A, 62nd Pa. Volunteers, in 1861, and served until he received an honorable discharge on account of sickness. Shortly after returning from the war, and while yet a young man, he became connected with the bridge department of the Pittsburg, Ft. Wayne & Chicago Ry. He erected the well known lattice truss iron bridge, spanning

HOLLAND W. FLETCHER.

the Allegheny river at Pittsburg. Later he became connected with the Iron City Bridge Works, as superintendent of erection, and served in that capacity 24 years. During his connection with the bridge company, he built the Smithfield Street bridge, spanning the Monongahela river, at Pittsburg; the Mt. Oliver passenger and freight incline; the Junction bridge at 33rd Street, Pittsburg; and the first building of the Westinghouse Air Brake Company. In 1886 he accepted a position as general bridge inspector for the Chicago & Northwestern Ry., with headquarters at Chicago, which position he held for fifteen years. Since resigning from that position he has lived a retired life.

Mr. Fletcher was a member of Davage Lodge No. 374, F. & A. M., of Allegheny City. He was a man who was always congenial, and it was a pleasure to meet him. He had a smile and a kind word for all with whom he came in contact.

MEMOIR.

Chas. M. Large, elected a member of this association, at Chicago, in 1896, died April 29, 1910, after a protracted illness.

Mr. Large was born in Beaver Falls, Pa., March 9, 1841. He began work for what is now the Pennsylvania Railroad Company, in 1859, and was in the employ of that company continuously until the close of his life. He began service as a regular carpenter, but was promoted to the position of foreman of carpenters, which position he held until 1872, when he was again promoted to the position of master carpenter, which position he occupied, until his last promotion to a better country. His life-time service with the Pennsylvania R. R. was one of loyalty to the company, and honor to himself. He had not only loyalty in his heart, but a thorough knowl-

CHAS. M. LARGE.

edge of business, and was a man who commanded the respect of his men.

Mr. Large was married May 28th, 1861, to Miss Sarah J. Bricker, who survives him. He was the proud father of six children, who are all living: Frank Large, of Sharon, Pa.; Mrs. Jessie Clark of Mahoningtown, Pa.; H. M. Large, of Ft. Wayne, Indiana; C. M. Large, Jr., of Pittsburg, Pa.; J. F. Large and Mrs. Lizzie Henry, of Jamestown, Pa.

Mr. Large was for many years, a member of Union Lodge, No. 259, F. & A. M., of New Brighton, Pa. While a young man he joined the Methodist Episcopal church, and remained a true and faithful member throughout his life. The funeral was conducted from the Methodist church, at Jamestown, Pa., on May 1st, Rev. E. W. Robinson officiating. The large attendance, profusion of flowers, and tears which fell freely, told the story of how Mr. Large will be missed by all who knew him. The city in which

he lived, the railroad company for whom he worked, the church with which he was identified, will all miss Mr. Large, but none so much as his devoted wife, who has always been at his side when he attended the various conventions. He has left this world of activity to accept the rewards of a pure life.

MEMOIR.

Charles Carr, one of the early and active members of this association, died at the home of his brother, in Rochester, New York, on March 31, 1910, of paralysis, after an illness of many months. He was born in Niagara Falls, New York, on April 21, 1837, residing there during his early life, and

CHARLES CARR.

obtaining an education in that beautiful location with its pleasing, natural surroundings.

In the days of his early manhood he began the bridge building trade, working under an older brother, acquiring mechanical knowledge, assisting in felling the timber and building many of the important wood-constructed truss bridges in that vicinity. Continuing in this work he superintended and constructed bridges for various railroad companies.

In 1873 he was made superintendent of bridges and buildings of the Canada Southern R. R., with headquarters at St. Thomas, Ontario, handling construction and maintenance for thirteen years. In 1886 he was transferred to Jackson as superintendent of buildings of the Michigan Central R. R., that company having acquired the Canada Southern. This position he retained regularly until retired on the pension list, at the age limit, the first day of January, 1910.

Mr. Carr was married in early life. His wife, being an invalid for many years, preceded him in death by only a few months. He is survived by a brother, Henry C. Carr, of Rochester, New York, who is associated officially with the bridge department of the New York Central R. R.

Fraternally, he was a member of the F. & A. M., having for years been a Knight Templar. He was also a member of the Episcopal church, being for a number of years one of the vestrymen.

The funeral services were held at Rochester, at his brother's residence, and interment took place at Pekin, N. Y.

During the many years of his wife's illness there was no trouble too hard, no request too great; and in his own affliction no complaint was heard.

Mr. Carr was elected to membership at the eighth convention held at Richmond, Va., in 1898.

MEMOIR.

Jacobus Vander Hoek, elected a member of this association at Boston, in 1906, died while on duty, December 22, 1909.

Mr. Vander Hoek was born at Goes, the Netherlands, March 19, 1862. He received his early education in the public schools and graduated from the high school of his native town, in August, 1879. In September of the same year he entered the Polytechnic School, at Delft, in the Netherlands, and graduated as Civil Engineer in July, 1883.

During 1884, he was employed as inspector on the construction of a dyke across the "Het Slaak," a shallow tide water 1½ miles wide, and made surveys and soundings for a record map of adjacent waters, covering the area of six square miles. In 1885 and 1886 he was employed by the Dutch government as assistant engineer, in charge of a party resurveying the principal rivers of that country, and triangulated about 25 miles of river. In 1886 he was engineer in charge of submarine shore protection for the "Polder of Schouwen," the Netherlands.

In December, 1886, he left his native land for the United States, arriving in New York, December 25. From the latter part of 1888 to the beginning of 1890 he was employed by the Wheeling Bridge & Terminal Railway Company, W. Va. The work comprised steam railway construction, a bridge 2,000 feet long, including one span over the Ohio River, 525 feet long; three tunnels from 400 to 2,400 feet long, all double track and heavy work throughout.

In 1890, he entered the service of the Lehigh Valley R. R., and continued until July, 1909. During that time he was engaged as chief draftsman, assistant resident and division engineer. When the main line was extended from Sayre to Buffalo he was employed as chief draftsman, designing masonry and other structures; also as resident engineer in charge of certain sections of this line. In 1903 he was appointed division engineer of the Buffalo division of the Lehigh Valley R. R., and had charge of maintenance work until July, 1909.

On July 12, 1909, he entered the service of the Lehigh Coal & Navigation Co., at Lansford, Pa., to take charge of the railroad maintenance, water supply, land surveys, and new outside construction on the extensive mining properties of that company in the anthracite coal fields. His exceptional ability was thoroughly recognized by his employers and his work and results fully appreciated. He had but laid his plans and perfected a proper organization when on the afternoon of December 22, 1909, while inspecting the work of laying a new water main through the Lansford tunnel, he met death by being run over by a locomotive, and his successful professional career was thus sadly ended, dying at his post of duty. His assistant, who accompanied him on this inspection, met with the same lamentable fate.

Mr. Vander Hoek was married in New York City, May 30, 1896, to Johanna Vander Bent, and is survived by his wife and two children.

MEMOIR.

Daniel Robertson, elected a member of this association at Richmond, Va., in 1898, died at his home in Oakland, Cal., July 9, 1910, after forty years of faithful service with the Southern Pacific Company.

Mr. Robertson was born in Cape Breton, Nova Scotia, March 15, 1840, and moved to California in May, 1869, at which time he engaged in mining at Grass Valley. In September of the same year he joined the forces of the Central Pacific road, then at work building the initial transcontinental line over the Sierra Nevadas. He retired after forty years of faithful service, and his death following his retiring from active service a few months previously, at the age of seventy years, brought his fellow workers and friends to a full realization of his worth as a man and friend. He was recognized as a specialist in his line. The forty years of continuous service made him a stalwart man with keen perception and infinite resourcefulness. The genial and lovable nature of Daniel Robertson is testified to by all of his friends and acquaintances.

After the first two years of service for the Railroad Company in constructing bridges and snowsheds in the mountains he was transferred to the San Francisco Bay region, with headquarters at Oakland. For the next twenty years there were located at this point the great mills, docks and yards of the Central and Southern Pacific Companies. Here were designed and framed the multifarious structures, steamboats, bridges, turntables, enginehouses, depots, hotels, etc., for hundreds of miles of railroad, reaching from Ashland, Ore., to San Antonio, Tex. This was the age of timber, and the design, workmanship and standards set by these people at this time are not excelled.

During this period Mr. Robertson was the active agent in general charge of the outside work on these structures. Of late he was engineer in charge of maintenance of bridges and buildings on the Western Division of the Pacific System and Southern Pacific Company.

When the rolling mill and forge supplanted the saw mill in producing raw material for railroad structures, he was equally apt and resourceful. During the next ten years, 1890 to 1900, mile upon mile of wooden truss bridges or pile piers were, under his personal direction, replaced with steel, stone and concrete—many of the renewals requiring special skill in preparing foundations and replacing structures under traffic. The beginning of the last decade found him still vigorous, still the right arm of the management, upon whom they never called in any emergency without quick and satisfactory response. He seemed to defy age and its decay. His mentality merely ripened and his judgment matured. Those familiar with the scope of the enterprises carried to a successful conclusion by the Southern Pacific Company. in California during the past ten years will appreciate the problems given him to solve. But the best metal becomes fatigued under severe stress and, suddenly, when all his comrades and well wishers were congratulating him on a well-earned retirement with apparent prospect of many years of quiet enjoyment before him, the dread reaper swung his scythe and our friend was with us no more.

A man educated solely in the school of experience, his judgment was unerring. As an executive he had few equals. Of a genial, kindly nature, all with whom he came in contact loved and trusted him. Honored in his family and private life, trusted and beloved by his business associates, his career is one of which his friends and this organization, of which he was an honored member, may well be proud.

MEMOIR.

William Renton, elected a member of this association, at Washington, D. C., in 1906, died May 16, 1910, from injuries received in an accident at Tiffin, Ohio.

Mr. Renton's death was a tragic one. While studying a blueprint for

the purpose of outlining some repair work on the Baltimore and Ohio R. R. bridge over Washington Street, in Tiffin, he was struck by a train and instantly killed. Those associated with him in the work saw the danger and called frantically to him, but on account of a train on another track he did not hear their warning and was caught by the train, picked up by the pilot and carried some distance. He was a man of very even temperament, and it is said by his superior officer, with whom he was associated for seventeen years, that he never saw him angry or flustrated. He was one of those steady men, always on hand, who could be relied on in cases of washouts, fires or any other emergency, and was always found in the front leading his men in a practical way. He had a personality that was to be admired and that drew men to him.

Mr. Renton spent practically all his life in hazardous callings, having served throughout the Civil War and most of the time since on railroads. He had numerous close calls from death, but had escaped until past the seventieth year of his life. Some years ago he was struck by a train at Rock Island Junction and three years ago was hit at Albion, but he was only slightly injured in each case.

Prince Edward's Island, near Nova Scotia, was the birthplace of Mr. Renton, in November, 1839. His age was therefore seventy years and six months. His parents were Scottish. They moved into the state of Maine while William was a boy. As a member of an Ohio regiment, Mr. Renton served throughout the war of the rebellion. He was twice promoted and was discharged at the close of the four years' conflict in 1865. After having been a foreman on the construction of Eads bridge, at St. Louis, and working on different railroads, Mr. Renton came to the B. & O. R. R. in March. 1876. He began as a carpenter in the repairing of a bridge at Delaware Bend and was soon promoted to a foremanship. In 1881 he was appointed road supervisor of the east end of the Chicago division, and in 1885 was given charge of the entire division as supervisor of bridges and buildings. The title was afterward changed to master carpenter. In 1892 the Akron division and the Wooster and Millersburg branch were also placed under Mr. Renton's supervision. On Dec. 1, 1901, his territory was again cut down to the Chicago division only, with no change in salary. He has filled that position since. He was one of the oldest men, in age and length of service, on the road. He could have retired with a pension years ago, but he had never been sick, was in good health and preferred to remain at work. He was continually looking after his duties and was an exceptionally faithful, conscientious and valuable employee.

Outside of his home and his work Mr. Renton took much interest for a number of years in maintaining the G. A. R. post in Garrett. He was commander, and held together in a body those few old soldiers who survived. He was also a member of the Red Men and a consistent communicant of the Episcopal church. After living at Hicksville and Defiance, Ohio, and Walkerton, Mr. Renton went to Garrett in 1885 and resided there until his death. His first wife was killed at a street crossing in Chicago in 1900, and his only son died in 1897. In 1901 he was married to Mrs. Lena Reesh. She and a half sister in the East, whom Mr. Renton had not seen for over sixty years, were his nearest relatives surviving. Three nieces live in Chicago and another niece, who is a physician and missionary, is in India. He had three stepchildren: Mrs. Harry B. Burke and Edward Reesh, of South Chicago, and Mrs. A. C. Wells of Keyser, West Virginia. Mr. Renton was one of the most highly respected citizens of Garrett.

The funeral services were held at the home, Rev. H. A. Wilson of Emmanuel Episcopal church officiating. The remains were taken to Defiance, Ohio, and buried in the cemetery where the remains of Mr. Renton's first wife, his son, his father and a brother had already been placed.

MEMOIR.

Ed. M. Gilchrist was elected a member of this association Oct., 1897, at Denver. While engaged in traveling over his division on a motor car he was struck by an extra train, July 16, 1910, near Milan, Mo., and died the same day. The body was taken to his home at Centerville, Iowa, and from there to Keokuk on a special car, where the burial took place from the home of Mrs. Gilchrist's brother, Henry Alton. A large body of railroad men were in attendance at the funeral.

Edward May Gilchrist was born at Westminster, Vt., Jan. 18, 1846. From his infancy he lived with his parents at Hillsgrove, Ill., until July, 1862, when he enlisted in the 71st Ill. Vol. Infantry, under his brother, Gen. Chas. A. Gilchrist. In March, 1864, he received an appointment from Adj. Gen. Thomas, as 2nd lieutenant in the 12th La. Vol. Inf., afterwards U. S.

ED. M. GILCHRIST.

Col. Inf. Co. H. In Feb. 1865, he was promoted to first lieutenant and, in Nov. 1865, to the captaincy. When in camp at Vicksburg in 1865, he nearly succumbed to typhoid fever.

Mr. Gilchrist was married at St. Marys, Ill., Dec. 25, 1866, to Mary Jane Bolts, who died in Sept., 1881. Two children were born to this union, Helen Frances, who died in Denver at the age of twenty-five, and Mary Albertine, who survives her father. In 1883 he was married to Lucretia Alton, of Keokuk, who survives him. Their only child, Horace, died at the age of eight.

When the Carthage & Quincy R. R. was built, Mr. Gilchrist was one of the surveying party that located the line, during the winter of 1870-71. He then bought a farm near Adrian, Ill., on which he lived for a number of

years. He afterwards returned to engineering work and for 31 years was with the C. B. & Q. R. R., in various capacities as engineer, always holding responsible positions, with headquarters at Keokuk, Brookfield, Hannibal and finally at Centerville, where he was resident engineer. Mr. Gilchrist was an expert in construction work, a capable civil engineer, and a man of energy and ability. He was a valued official and employee and was most dependable in emergency cases, like washouts and wrecks, and even handled an engine on a passenger train at one time during a strike on the road.

President.—The next will be the report of the relief committee.

REPORT OF RELIEF COMMITTEE.

I wish to advise that during the past year there have been received three different applications from members for positions. Circular letters were sent to various members of the association who would probably be in a position to furnish employment. At present there are no applications for relief pending.

Respectfully submitted,

ARTHUR MONTZHEIMER,
Relief Committee.

Secretary.—I have a letter from Mr. H. M. Henson, of Beaumont, Tex., which I would like to read.

Beaumont, Texas, Oct. 14, 1910.

Mr. C. A. Lichty,
Secretary American Railway Bridge and Building Assn.,
Dear Sir:—

I am sorry to inform you that I am unable to be in attendance at the convention this year. I have been confined to my room for two months while suffering from diabetes and do not seem to improve very much. I fear that I will never be able to work again.

I have been with the Santa Fe for some time as inspector of foundations and masonry construction, a very good position and fine people to work for.

I shall have to ask you to wait on me for my dues as I am on pretty heavy expense and nothing coming in. Misfortune has been my lot for several years, and there does not seem to be any let up, but "It is a long road that has no turn." I know you will have a splendid time at the convention, and I wish to be remembered to all of the members in attendance.

Tell my friend, Mr. Camp, that I will have to withdraw my name from the subscription list to the Railway and Engineering Review, on account of reducing expenses. With best wishes for the success of the convention, I beg to remain,

Yours truly,

H. M. HENSON,
875 Glass House St.

Mr. Rear.—I make a motion that Mr. Henson's dues be remitted for as many years as may be deemed necessary. Motion carried.

Mr. Rettinghouse.—I move that the case of Mr. Henson be referred to the committee on relief with instructions to offer any assistance that may be found necessary. Motion carried.

Mr. M. F. Cahill kindly volunteered to have the Railway Review continued to Mr. Henson's address.

Mr. Stannard.—I would like to make a motion that Mr. C. W. Gooch's back dues be remitted, and he be made a life member.

Motion duly seconded and carried.

Mr. Lichty.—I do not know whether it will be in order or not, but Brother J. M. Wells of the Santa Fe is with us. He has been quite feeble, and I make a motion that we remit his dues, and that he be made a life member.

Motion seconded and carried.

Mr. Lichty.—We have another old brother by the name of Alexander Amos, of the Soo Line, of Minneapolis. He has been pensioned and retired for some years. His income is small, and I know that he would appreciate it if we did anything for him. I don't want to make another motion, and I leave it to you.

Mr. Clark.—I make a motion that Mr. Alexander Amos be placed on the retired list, as a life member.

Motion duly seconded and carried.

President.—We will now proceed to take up the subjects for report and discussion. I understand that subject number one is not ready, so we will proceed with number two on Cast Iron Pipe Culverts, and return to number one later. (See discussion on subject No. 2.)

Adjournment was taken at 5:30, until 7:30.

EVENING SESSION.

Tuesday, Oct. 18, 1910.

Meeting called to order at 8:00 P. M.

President.—Gentlemen, we will have the pleasure of listening to a paper prepared by Mr. H. Rettinghouse, entitled "Regularity and Safety."

REGULARITY AND SAFETY.

BY H. RETTINGHOUSE.

The rules adopted by the American Railway Association, which form the basis of rules and regulations that are in force on nearly all railroads in the United States, clearly prescribe the course to be followed in order to bring about regularity and safety. The safety of trains and passengers is of paramount consideration, and to this all work of construction and maintenance of railroads must be subordinated, together with regularity of train service and the comfort and convenience of passengers. Rules are made to be obeyed strictly, in order to make them efficient, and if there are any rules that cannot or ought not to be enforced, they should not exist. The first and last rules, respectively, as contained within the book of regulations

of many railroads and printed conspicuously so as to emphasize their importance, read about as follows:

"In case of doubt, adopt the safe course. Speed must always be sacrificed for safety."

"Take no risks. Remember that it is better to be delayed by adopting a safe course than to have a train meet with accident by neglecting to take all precautions possible."

With all persistent efforts, therefore, which have been made, and are constantly being made by railway officials to bring about conditions of regularity and safety in the operation and maintenance of railroads, it is a matter of great discouragement to discover that accidents on railroads are on the increase, instead of on the decrease. Many of the railroads, being keenly awake to the situation, are inaugurating a systematic campaign in order to bring before their employees the situation through lectures and other means, with the object in view of educating them for the observance of greater care and safety.

It was the writer's privilege to listen to a very able address delivered to employees of the Chicago & Northwestern Ry. by Mr. Ralph C. Richards, general claim agent, and, in fact, this address inspired the writer's thoughts to confine within this paper the impressions produced by the address, for the benefit of the railroad world in general, and more especially for the benefit of that vast army of the railroads, the bridge and building men, who unfortunately contribute heavy toll to the annual list of dead and injured. Mr. Richards' address was delivered at various points on the system, usually at division headquarters, or wherever a gathering of employees could be assembled, and it may be said that results were gratifying in the large and appreciative audiences. The address has since been published in book form, entitled, "Conservation of Men," and if this paper contains frequent quotations from the book, and address, it is but a fitting tribute to Mr. Richards and the very able and earnest manner in which the subject was handled.

The Interstate Commerce Commission has published, in tabulated form, figures showing the number of persons killed and injured on railroads in the United States. All railroads are required by law to report all personal injuries and all accidents, and the figures are, therefore, authentic. What is more, they are appalling, and we must ask ourselves the question: "What should be done, with these appalling conditions facing us, to improve matters?" Let us quote from Mr. Richards' book, for an answer: "We must have 'Regularity and Safety,' and in order to have these, we must have coöperation. Let the example of older men in the service be an influence, a guide to bring the younger men up to the right standard, thereby decreasing the risk of death and injury for all, and at the same time increasing the efficiency of the organization for which we are working."

I may say that it is well to analyze the situation thoroughly. Great accidents, collisions, etc., are not the principal causes of this dreadful list of injuries and deaths, and we learn from the statistical records that only about one-sixth of the deaths and one-fifteenth of the injuries are due to great disasters and collisions. The little things that happen every day cause the other five-sixths of the deaths and fourteen-fifteenths of the injuries. Just think of it: In ten years 78,658 people were killed and 722,039 people were injured and crippled by little every-day accidents on railroads in the United States, the majority of which certainly could have been avoided by regularity and safety properly applied.

It has occurred to me that our system of hiring men is altogether wrong, and when we go somewhat deeper into the question, we must confess that we have not much of a system in that respect, and it is high time that we adopt one. We must be careful in the selection of men for the service, and I maintain that it can be done, notwithstanding the much heard cry, that the standard of the rank and file has degenerated. It is the cry of the pessimist, and of the man who has no business to be classed among the employing officers of railroads. I claim that the standard of man, by reason of better education, and consequent better enlightenment, is of a

higher grade than it has been, and we are required to possess the necessary qualifications to pick out such men as are suitable for our work from a standpoint of general fitness and safety. It is, then, merely a matter of discipline and management to perfect an organization, and educate all new men along the lines of regularity and safety, and not to educate these men by costly and dangerous mistakes. We, as supervising officers of the bridge and building service, are reluctant to admit any possible defect in our respective organizations. We are priding ourselves on the merits and accomplishments of our subordinates and ourselves. We are justly proud of the undeniable facts that the rank and file and the officers of the bridge and building service are the most loyal and faithful employees which any railroad has at its command, men who instantly, and without question of consequences go into the very jaws of death on emergency calls, to perform such duties as will protect the life of patrons and employees, alike, and the property of the company. We are often particularly proud of this or that foreman, whom we may have followed with a watchful eye through years of faithful, loyal and industrious service, as a hand in one of the crews, until, finally, we have decided that he is ripe for a foremanship, and clothe him with the authority and responsibilities of one. Are we always in such cases exercising regular and safe judgment? Are we always following the correct interpretation of the rules and regulations which spell "regularity and safety"? Do we always in the stress of business consider what might happen if we do not do things in the right way? And do we always in the selection of a foreman consider the railroad golden rule: "Remember that it is better to have a delay than to cause an accident?" Unfortunately, we cannot answer that question in the affirmative, and we are apt to err in our judgment. It is this fact and these conditions which the writer has uppermost in his heart and mind as being well worthy of considerate and thoughtful analysis.

The writer had, only a few months ago, a sad occasion to deliberate on the subject. A bridge foreman, whom, for every reason, we considered fit to be trusted with the most difficult work, miserably failed to do his duty, and through failure of observing the most common rules of regularity and safety, through inconceivable and flagrant disregard of special instructions given him, caused the collapse of an iron span which a locomotive and part of its train had almost crossed, resulting in the loss of the life of the engineer, the serious injury of the fireman, and considerable destruction of valuable property. This sad occurrence has served as an object lesson, which will never be forgotten by those affected by it. We may be justly and severely criticised for destruction of property, but we can never ease our conscience, no matter how far fetched our responsibility may be, when death steps in, when widows and orphans are lifting their appealing and accusing eyes at us, and when we see a promising life blighted by being maimed and crippled. Railroad managements, while profoundly regretting the loss of property occasioned by avoidable accidents and the pecuniary losses occasioned through deaths and injuries would, however, gladly contribute almost any amount of money if thereby a better condition could be brought about. It is not a question of dollars and cents, it is just a question of saving human life, the most valuable thing in the world, which, when once it is gone, can never be brought back. It is trying to save men from losing their legs and arms, trying to save making widows and orphans, and trying to save destitution and misery.

But it is the little things we must take care of, the little cases of negligence which happen every day, which cause these accidents. Let us quote some examples: Two bridge and building districts join at some more or less important terminal where we have roundhouse, shops, coal chute, water columns, etc. Nine times out of ten the supervising officer who has charge of the maintenance of the plant has his headquarters at the other end of his division, while his neighbor lives much nearer. Naturally, the officer in charge believes that he is getting the worst of it and his neighbor should look after the plant. What is the result? The supervising officer takes a chance at repair matters, and his neighbor—why, it is none of his

business and he does not remember that in case of doubt as to his duty in the matter he should adopt the safe course and make safe a rotten ladder of a coal-chute that may make a widow of the coal-chute tender's wife tomorrow.

Two pile-drivers are engaged at driving piles for the foundations of adjoining bridges. Foreman John is wondering why Foreman Jim is beating him continually as to the number of piles driven in a given time. He does not wonder, when, several months later, after completion of the bridges, the one where Foreman Jim was making double time gives way under a strain and the investigation shows that the piles were driven with a crosscut saw. Foreman Jim is distracted when the facts become known, and so are his superiors who trusted him to do the right thing, and who justly assumed that he knew the laws of regularity and safety, and who would "take no risk" and would remember "that it would be better to delay the work through the adoption of a safe course than to have a train meet with an accident."

Take, for example, the unloading of material from cars where it is piled up alongside the track. The rules say there should be six feet clearance, so that men will not be knocked off cars. Does it ever occur to you that we, as supervising officers, are not always adopting the safe course, that we are not always following the rules of regularity and safety in sometimes ignoring that iron-clad rule? We may wish to ease our conscience by saying that the superintendent is after us with a whip and a dog to get those cars released in a hurry; didn't have time to observe the clearance; just threw it off to get those cars released. And a day or so afterward a switch engine places some more cars and the switchman gets caught between the lumber pile and the car. Do you think that you could come with a clear conscience to that switchman's widow? Do you think that you could stop misery and destitution in that house of death by telling the story of how it happened? Do you not think it would have been better to adopt regularity and safety and to sacrifice speed for safety in the unloading of those cars?

If we are to change these calamities, we must coöperate. Failure to coöperate between adjoining division departments of the same class, and between different departments on one division, will tend to increase accidents and injuries, and it is high time to apply ourselves vigorously in order to eliminate these old-time prejudices, and we can do it if we are determined. If the other fellow is stubborn and narrow-minded, we can get him in line after a while by making him feel ashamed of himself. Just think of a bridge foreman or carpenter foreman getting his foot caught in an unblocked frog or guard rail. Does that foreman stop to block that frog? Not so, because from his narrow viewpoint it is none of his business. Just think of a section foreman walking several times a day over a platform that has a hole in it big enough to trip a man and break his bones. Should such things occur?

These things not only swell the list of accidents and draw on the exchequer of the company, but they breed disregard of the common rules of regularity and safety. It must become the duty of every division official and employing officer to enter into the field of coöperation, make it a study, and help to educate ignorant, narrow and obdurate minds. The writer is a firm believer in the so-called Major Hine plan, which is being introduced on all of the divisions of the Harriman Lines. Without going into a discussion of the plan proper, it is well known that it has as its basis coöperation in the fullest sense of the word, and the object is to make division officers observant, not only of their special line, but also that of others. The plan must produce regularity and safety, and it is reported that results so far obtained are very gratifying.

It is perhaps not so well known, as it is ignored by many of us, that in so far as regularity and safety are concerned, we have that plan on all railroads, as it is our prescribed duty to observe all defective conditions that might lead to accidents and see to it that they are remedied.

Why don't we do it? Why don't we follow regularity and safety, and why don't we in case of doubt adopt a safe course? On the Chicago &

Northwestern Ry. we have now on each division an employees' committee, consisting of one conductor, one engineman, one yard foreman, one agent, one section foreman and one freight inspector. The members of this committee make notes from time to time of all dangerous conditions or practices which may come under their observation, and they take immediate action on matters that can be corrected by themselves, or make recommendation of matters beyond their control to a "division committee" consisting of the superintendent, master mechanic and division engineer. The members of the "employees' committee" meet the "division committee" once each month to present their recommendations and draw up their report. Promptly after these monthly meetings the "division committee" submit a report to the central committee, consisting of the assistant general superintendent, engineer of maintenance and general claim agent, advising action in each case or their recommendations. Much good has already been done by these committees, and splendid results in general must certainly follow. It is my understanding that similar committees for regularity and safety and for the conservation of men are at work on many other railroads, and it is being realized by officers and subordinates alike that we must have action of some kind to prevent this awful slaughter, that we must get rid of these chance takers. We are of a nation of chance takers, and the bridge and building service has its share of men of that description.

There is now a bill for a federal law to come before congress which probably will be passed and which makes it a misdemeanor for a railroad company to leave obstructions of all kinds in yards and along tracks where switching and train crews are obliged to walk, and may cause them to trip and fall and become injured or killed. Should we wait until that law is passed? Should we wait and see the railroads branded with the ignominy of being unable to care for their regularity and safety and to protect their own employees? Decidedly not. We must rise to action and we can and will do it.

In Germany, where they enforce the laws (we don't do it here any more than we enforce the rules), they have four murders annually for every million of people. In the United States, where we don't enforce the laws, we have 120 murders for every million of people. In Germany, where they enforce the rules for operating railroads, they have less than one-half the fatalities to employees that we have in the United States, in proportion to the number of men employed. They have one-half the fatalities we do, because they obey the rules and because they remember "that it is better to cause a delay than it is to cause an accident."

How much better it would sound if we could have reported to the Interstate Commerce Commission during the last year that there were seventeen hundred employees killed on the railroads of the United States, instead of thirty-four hundred. Wouldn't it be safer today for all the rest of us? Wouldn't it look better? Is there any reason in the world why we can't run our railroads as safely as they run theirs in Germany?

We claim to employ better educated men, men of higher intelligence, and we pay better wages. Why can't we do our work just as well and with as much measure of safety as they do theirs? What is the trouble and what is the matter with us?

Just as soon as we get down to business, and I know you and I and all the rest of us will do it, and coöperate, in the broadest sense, just as soon as we devote some of our time to employing safe men and educating these men after we get them, just as soon as we emblazon in our minds the rules "In case of doubt adopt a safe course," and "Remember that it is better to be delayed by adopting a safe course than to cause an accident by neglecting to take all precautions," we will attain our great object. We will have regularity and safety.

Secretary.—While in attendance at the Roadmasters' convention at Chicago last month I had the pleasure of listening to a paper which was read by Mr. W. M. Camp, our editor, entitled

"Some Benefits of Association." It appealed to me that the greater portion of the paper would apply to our association as well as to that of the Roadmasters, and I am sure that you would all appreciate it. If you will permit me I will ask Mr. Camp to read the paper.

The paper was read by Mr. Camp.

SOME BENEFITS OF ASSOCIATION.

BY W. M. CAMP.

The periodical meeting of railway officials for the discussion of methods of work and various matters of practice long since became a well-settled custom in this country. In the development of the railways it was early seen that men in responsible charge of the properties could profit by meeting together for the purpose of comparing notes of their work, and as time went on the consolidation of short roads into continuous lines of railway and the through routing of traffic necessarily gave rise to questions that called for the adoption of common standards. Between the years 1880 and 1890 a number of associations representing various departments of railway work were formed, in addition to the few then existing, and from time to time new ones have been organized, until now nearly or quite every department of railway work is represented by its own organization. The influence which these associations have had in disseminating knowledge has told in the improvement of methods and materials of railway construction, maintenance and operation, to an extent that can scarcely be fully appreciated.

The purpose of railway association work is to draw out information concerning methods, designs, the economies of construction and maintenance, and the safety of railway operation; and to adopt or recommend such approvable practice as may have a general application throughout the railway field. The occasion for the adoption of standards usually resides in some urgency of a situation enforced by practical necessities.

To a very large extent the standards of two railways may be, and usually are, worked out on different lines, and so long as they are operated independently no material difference in maintenance economy may appear; but the consolidation of one railroad with another usually enforces some degree of standardization of appliances in order to reduce the storekeeper's stock of supplies to reasonable proportions. So important has consideration of this principle become that many or most of the large railway systems now have their own association of officers of the maintenance of way department, who discuss practice as it may be affected by local conditions and, working through committees in the ordinary way, adopt standard designs and methods. To such individual associations the work of the national organizations is undoubtedly used for reference and comparison; and, on the other hand, the training which these men received by way of observation, analysis and habits of study on their own roads should better fit them for intelligent work in the associations of larger scope. The Pennsylvania Lines West, the Chicago & Northwestern Ry. and the Chicago, Milwaukee & St. Paul Ry. are some of the roads which have organizations of this kind.

The plan of conducting association work admits of some discussion. The scheme of accomplishing the results aimed at consists in the presentation and adoption of committee reports and resolutions, the reading of individual papers, and the discussion of the reports and papers by the members in general. The purpose of a committee report may be to investigate the development of a line of work merely for the purpose of conveying information, in which case it is received as information, in order to print it in the proceedings; or it may be received as a report of progress,

with the same disposition. When a report is presented for the purpose of adoption of standards or for the recommendation of practice it is, or at least should be, accompanied by definite conclusions, which embody, in concise language, the meaning of the association's action, in which case the descriptive matter making up the body of the report is usually explanatory of details, or illustrates the application of principles set forth.

It is the province of a committee to look over the whole ground of its subject, analyze the situation, collect and classify facts that are pertinent to questions involved, and present, as far as possible, a summary of practice, thus drawing matters to a focus and putting the sense of its findings in shape for convenience of discussion. In fact a committee may well point out those things toward which, in its judgment, attention may be concentrated. Irrelevant matters may receive only incidental consideration or be withheld from the report. This may or may not require a statement of conclusions. In fact it is easy to make conclusions cover ground too broadly, and it is always an important matter for a committee to determine whether conclusions or recommendations will be appropriate or acceptable, or simply to stop at having pointed out merits of devices or methods, advantages or disadvantages, leaving each individual free to form his own conclusions. Data of the highest importance may frequently and properly be "received as information," merely.

The advantage of standardization, as far as such can be consistently carried, cannot be overstated, but there is a limit to the extent to which standards and recommended practice can be carried. Beyond this there is a large number of questions, pertinent to the interests of every railroad man, which can profitably be discussed by railway associations, but which are so diverse in application to meet different situations and conditions, that no standardization or recommendation is fitting, and the attempt to pass upon them by official action of an association results either in waste of time or in the adoption of unsatisfactory conclusions.

There are many questions touching which practice is so well formed on established lines that conclusions or recommendations can well be drawn. There are other questions which can most profitably be discussed for a number of years without either conclusions or recommendations, such as those pertaining to new lines of work which must, of necessity, be experimental for a time. There is then much work where the practice is so dependent upon special conditions that general conclusions or recommendations are not applicable; but there is no question of practice from which some good cannot be obtained by discussion.

Much information of importance may be brought before a meeting with no view to adoption of recommendations. Mere descriptive data of certain lines of work, brought out from year to year, may be of value and have an effect according to its worth. Data of experience on a particular road are more than likely to find some one working under similar conditions on another road who is eager to get the information.

The educational value of discussion cannot be too highly rated, for it often puts flesh and blood on a mere skeleton of a committee report that has been haggled down or compromised through disagreement in the committee. Ordinarily the aggregate of individual thought in a convention should be superior to the best possible expression of a committee. A committee report may reasonably be expected to fall short of the possibilities of discussion, and even discussion seldom rises to the full latent force of the membership. A vote on a committee report without free and full discussion is duty only partially performed, and the action may be misleading, because action on questions only one side or one phase of which is presented, may ignore many qualifying terms which discussion might otherwise have brought forth. And it is one of the valuable things about a discussion that it may point out limitations in a practice which conclusions too loosely or too generally drawn may have overstated, but which, nevertheless, pass by the vote. In such event the discussion puts the conclusions in proper light before the inexperienced.

The educational scheme of the national engineering societies consists mainly in the presentation of individual papers, with oral and written discussions thereon. But very little of the work of these associations is through committee reports, and, as a consequence, there are but few subjects on which these associations, as a body, make recommendations. Individual papers are perhaps the best channel for recording opinions in a forcible manner. The words of the author stand in the paper unchanged, regardless of the trend of the discussion, which, as we well know, is not always the case with a committee report by the time the convention gets through with it. It should be said, however, that the practice of some associations is to leave the wording of the committee stand in the original form, or as first presented in the report, such changes as are made in course of the discussion being expressed in the conclusions.

Members will usually express themselves with greater freedom in the discussion of an individual paper than they may feel like doing by a proceeding which carries with it the sanction of the association; or a member might speak with less hesitancy if he knows that his remarks will simply go on record, than he would with the knowledge that his expressed opinion may have the effect of changing the sense of the matter offered by the committee. A paper and the discussion of it in full will very frequently indicate to the reader the consensus of opinion, just as well as though formal conclusions had been submitted and acted upon by the meeting or convention. On the other hand, the same thorough examination of a committee report and the ensuing discussion may sometimes cause one to form an opinion at variance with the sentiments carried by vote, for it is a common fault of all associations that the yeas and nays seldom constitute a full vote.

For treating a subject that deals with new or experimental lines of work, where the remarks are mainly descriptive, or on which decided opinion is not called for, the individual paper is particularly appropriate. The same is true when treating of work that is rather outside the field of the association, but which, nevertheless, may be of interest through some bearing it may have on the line of work which the association represents. The assignment of a subject to a single author who is particularly well fitted for handling it may also be a surer method of getting it before the association with some fullness than would result through the machinery of a committee the members of which are unfamiliar with the practice that is to be investigated. It is, therefore, well worth considering whether a subject that is to be brought before an association can best be handled by a committee or by a single author.

Not by any means the least of the benefits of association are the social opportunities. The acquaintances formed at the meetings enter one's life and make lasting impressions. The contact of experience and opinion wears off the rough edges and sharp corners, fills up the voids and has decidedly a poising and broadening influence. The people whom one meets in the conventions have been trained in his own school, and any desired knowledge associated with the particular vocation that is lacking in one may be found in another. Membership in such organizations and attendance at the meetings is indeed a pleasing experience, full of advantages in more ways than can be reckoned to business account. It is difficult to imagine a more practical and sensible way to combine business with recreation and opportunity to study the men of one's own calling. If those who have participated in these conventions a number of times will but reflect upon the extent and value of the acquaintances formed on these occasions, and then try to imagine how this same breadth of intercourse and knowledge of character could have been obtained in any other way, I think they will realize very strongly this phase of the benefits of association.

President.—Before we adjourn we will have the report of the nominating committee.

REPORT OF THE NOMINATING COMMITTEE.

Denver, Oct. 18, 1910.

To the Officers and Members of the American Railway Bridge and Building Association:

The nominating committee, after careful consideration, presents the following list of names for officers and members of the executive committee for the ensuing year:

President—H. Rettinghouse, Chicago & Northwestern Ry.
First Vice-President—F. E. Schall, Lehigh Valley R. R.
Second Vice-President—A. E. Killam, Intercolonial Ry.
Third Vice-President—J. N. Penwell, Lake Erie & Western Ry.
Fourth Vice-President—T. L. D. Hadwen, Chicago, Milwaukee & St. Paul Ry.
Secretary—C. A. Lichty, Chicago & Northwestern Ry.
Treasurer—J. P. Canty, Boston & Maine R. R.
Executive Members—T. J. Fullem, Illinois Central R. R.; G. Aldrich, New York, New Haven & Hartford R. R.; P. Swenson, Minneapolis, St. Paul & Sault Ste. Marie R. R.; G. W. Rear, Southern Pacific Co.; W. O. Eggleston, Erie R. R.; W. F. Steffens, Boston & Albany R. R.

R. H. Reid,
S. F. Patterson,
A. S. Markley,
W. O. Eggleston,
W. W. Perry,
Committee.

President.—A motion to adjourn will be entertained in order to accept the invitation of the management of the Auditorium to visit the "Streets of all Nations" which is now being held there.

Meeting adjourned at 9:00 P. M.

MORNING SESSION.

Wednesday, October 19, 1910.

Wednesday forenoon was occupied by discussion of the various subjects.

AFTERNOON.

The afternoon was devoted to a trip to Georgetown and Silver Plume, for which was arranged a train of six cars via the Colorado and Southern Ry. The trip was a pleasant one indeed.

MORNING SESSION.

Thursday, Oct. 20, 1910.

Meeting called to order at 9:15 A. M.

The secretary announced that a trolley ride had been arranged to take the party to the "foot-hills" during the afternoon.

Secretary.—During the past year I have taken it upon myself to publish two numbers of a small pamphlet, which you have all seen, called the "Bulletin." The object is to publish news items and notices, all of which may be of interest to the members of the association. I would like to have a vote of this convention as to whether you wish the publication continued.

It was voted unanimously to have it continued.

President.—We will next have the report of the Auditing Committee.

REPORT OF AUDITING COMMITTEE.

Denver, Oct. 20, 1910.

To the Officers and Members of the American Railway Bridge and Building Association:

We have carefully audited the books of the secretary and the treasurer and find them kept in a neat and practical manner. The reports as submitted by them to the association are found to be correct.

LEE JUTTON,
J. N. PENWELL,
G. ALDRICH,
Committee.

President.—We will now have the report of the obituary committee.

REPORT OF THE OBITUARY COMMITTEE.

Denver, Oct. 20, 1910.

To the Officers and Members of the American Railway Bridge and Building Association:

Whereas, Our Almighty Father, in his divine wisdom has deemed it best to remove from our midst eight of our respected members, thus reminding us of the shortness of life and the necessity of preparing for the one call that is sure to come, therefore be it

Resolved, That we deeply deplore and sincerely mourn the loss of these brothers: James D. Gilbert, Holland W. Fletcher, Charles M. Large, Jacobus Van der Hoek, Daniel Robertson, E. M. Gilchrist, and William Renton.

Resolved, That our secretary extend to the widows and families of these deceased brothers the sincere sympathy of this association and that a copy of these resolutions be printed in our proceedings and a copy sent to their respective families.

S. F. PATTERSON,
D. C. ZOOK,
D. L. MCKEE,
Committee.

Mr. Penwell.—I move that the report be accepted.

Motion seconded and carried.

Mr. Rear.—Mr. President and gentlemen: It has been a great disappointment to the members from the Pacific coast that we were not able to furnish a photograph of Mr. Robertson, of the Southern Pacific Co. to accompany the memoir. Mr. Robert-

son had been supervisor of bridges and buildings on the largest division of the system, and he started on that work when the road was being built, at the time when all the material was brought around the horn in sailing vessels, some of it taking a year. He was in charge of getting the material to the front, and those who knew him at that time and since have great respect for the grand old man and for his knowledge and ability. In March of this year he was retired on a pension, after serving 40½ years with one company and in one place, and at that time the members of the maintenance of way department gave him a banquet. At that meeting the assistant general manager, the head of all the departments, and the general manager of another road came there to do him honor. Speeches were made by old men giving him credit for what he had accomplished, and expressing adoration for what he had done for us. We little thought that in three months he would leave us, but it was a fact that within three months he died. He had been a strong man, with a large and powerful frame—a man we all called "Uncle Dan," and respected him as if he had been a relative. I feel it is not right to let this chance go by without telling you of him, so I took this opportunity. I believe that some of you have met him, and will remember him as a kindly old man, and we of the Pacific coast have not yet got over mourning for him.

President.—We have a letter from Mr. Stern, chairman of the committee on Subject No. 7, "Best method of numbering bridges,"which the secretary will read. (See letter under subject No. 7.)

REPORT OF COMMITTEE ON SUBJECTS.

The committee appointed for the selection of subjects for the next Annual Meeting begs leave to make the following report:

1. Fire-proofing frame and pile trestle bridges.
2. Derricks or other appliances for the handling of heavy material in supply yards.
3. Best method of numbering bridges (continued from 1910).
4. Arrangement of buildings and platforms for small towns, as to convenience and appearance, and location on either one or more main tracks (continued).
5. Sash, sizes and kinds of glass that are most economical to use in round houses and other shop buildings.
6. Best designs and most economical pumping engines—gasoline, oil or electric.
7. Records of bridges, buildings and other structures; showing their record from the time the structure was built, with cost of construction and maintenance.

8. Concrete tank construction.
9. Advisability of using brick veneer for station buildings.
10. Roofs and roof coverings. Recommend the types of roofings best suited for different types of buildings, with special reference to the kind and incline of roof deck; size and location of buildings; adaptability of the proper application by railroad men; necessity for painting or coating at stated intervals; probability of this being done; and fire retardant value. Also report on the value of guarantees, especially when material is applied by other than the guarantor.
11. Protection of embankments (continued).

J. H. Markley,
E. B. Ashby,
G. W. Rear,
A. A. Wolf,
W. W. Perry,
Committee.

Mr. Penwell.—I move the adoption of the report of the committee on subjects.

President.—You have heard the motion, I believe it was intended to include, as No. 11, the subject of washouts. The committee I believe consented to embody that in their report.

Motion Carried.

President.—The question of amendment to the constitution will now be taken up, the amendment as proposed being shown in the proceedings for last year, together with the remarks of the president.

Mr. Schall.—The constitution provides that notification should be given two or three months ahead of the meeting, so that everyone will know what is coming up.

Secretary.—It was not thought necessary to send out special notice of this, on account of its having been printed in the proceedings.

Mr. Schall.—Being published in the proceedings does not constitute a notice. I think a special notice should be sent out.

Mr. Rear.—As far as I am concerned, and as far as the majority is concerned, I think the notice in the proceedings is sufficient, and I think that inasmuch as the association will not be 25 years old for some time, we can vote on this question next year.

President.—We will pass this matter.

Mr. Patterson.—I feel under great obligations to our secretary for the special train which he arranged for from Chicago. I move that he be given a rising vote of thanks.

Motion carried.

President—If there is any further business it might come up now.

Mr. Rear.—It appears to me that our proceedings are of some importance, and I do not think that they are properly bound. I have had conversation with some of the members on the subject, and suggest that one copy of the proceedings for each member be bound in a permanent cover. I have no idea what it would cost, and whether the financial conditions of the association would warrant that kind of a binding. Until the matter is further discussed, therefore, I will not make any motion, but I would like to see each member have a permanently bound copy, and, if necessary, each member could pay something additional if the financial condition of the association will not warrant the extra expense. I would also suggest that each member be provided with such other bound copies as he would care to pay for.

Mr. Penwell.—I have been in the habit, ever since I became a member, of having my copies of the proceedings permanently bound in a good cloth binding. I regard this as an important matter for the proper keeping of my personal files. It has always cost me from $1.35 to $1.50 a copy. I do not know what it would cost the association, but probably a great deal less, and we could get along with a little less elaborate binding than I am using. If it could be done consistently, I would like to see the association have one copy bound for each member, but if not, then give the members the opportunity to have them bound at the reduced rate, which would be granted by having 400 copies bound. By having that number bound the work would probably be done at one-half the cost per copy that would be charged for a smaller total number.

Mr. Markley.—We seem to have a considerable amount of surplus funds, and I think that the association could stand the expense of this. I make a motion that the association pay the cost of the binding.

Motion seconded.

Mr. Penwell.—In order that the motion be perfectly clear, I understand that each member will be furnished one copy bound in cloth.

Mr. Markley.—That is the understanding: one copy for each member who is in good standing.

Motion carried.

President.—The next thing in order is the selection of a location for the next meeting.

Secretary.—Before that question comes up I would like to call your attention to the map which we have put up, showing the dates and places at which conventions have been held in the past. You will see that we have met only twice in the western half of the United States, but considerable pressure has been brought to bear by a number of the members of the association in the East to have the meeting next time somewhere near the center of population. The great majority of our members are in the middle part of the country. We have met, for the last two years, at the extremes, Jacksonville and Denver, and I make these remarks before you bring up the subject of the nomination of cities.

Mr. Rear.—I do not suppose any one here can say how glad we would be to have you come over on our side,—that is, to the coast—and if you feel that you cannot come over in a body, we would be glad to have you come individually. There is one reason why I would be against having all of you come in a body, as if you came that way you would not care to go back, and then some of us would lose our jobs. We anticipate having a great time in San Francisco in 1915, to celebrate the completion of the Panama canal, and we are making a terrible fuss over it; so I think we might, possibly, five years from now, get as far away as that. We are therefore going to make a special bid for 1915.

Member.—I believe we can all get together in Los Angeles next year, and I will nominate that place for the next meeting.

Mr. Costolo.—I am in favor of St. Louis. It is centrally located, the climate is fine there in October, and it is well qualified to take care of our convention.

Mr. Rettinghouse.—I believe it has been quite fittingly stated by Mr. Costolo that the climate is delightful in St. Louis at this time of the year. It may be unnecessary to say anything about a climate like this (in Denver), and I think there should be some flexibility in the dates of our meetings. We should have the meeting at the time of the year that is best suited to the climate. A remark was made by our secretary that we have met only twice west of the geographical center, and it should be borne in mind that there is a large country over here in the great Pacific Northwest, (indicating on the chart), which should not be overlooked. We cannot expect the members to come this far every year, but we should make the meeting place for the convention in such places once in a while, the same as we

are going to do with the southwestern lines. Perhaps some of you have been through the Pacific Northwest, and the Canadian Northwest but more than likely the great majority of you have no idea of the country. I have been over there, and I was surprised. They have no "two-for-a-penny" railroads in that country; they have railroads and improvements that would be a surprise to many of you. They are as far advanced in the way of building and maintaining railroads as any in this country, and in some respects they are ahead. Winnipeg, Canada, is an ideal place for a convention. I have been consulting some railroad men, and I can assure you that we would receive a great welcome if we held our convention in that city. It is easy to reach for all the members, via the Canadian Pacific, Grand Trunk Pacific, and Great Northern, and it is only one night's ride from St. Paul. Mr. President I nominate Winnipeg, Canada.

Mr. Penwell.—The center of population is 28 miles from Indianapolis, but I am not going to nominate Indianapolis this year. I would, however, like to see this convention go to Indianapolis some time later. I see on the map a place between Lake Huron and Lake Erie, on a beautiful river—a place where there are magnificent people, and congenial people, and many other things we might say if we had the time, but I will not stop to name them; I refer to the City of Detroit, Mich., which I will nominate.

Mr. Clark.—I nominate Montreal.

Mr. Scribner.—A good general plan to adopt, as something catering to the convenience of the members, would be to hold one convention in the center—that is, the center of the location of the members—then perhaps go to the extreme to the east, then to the center again, then to the extreme in the other direction. In that way the convention would be handy to all the members every few years.

Mr. Stannard.—I move that the nominations be closed.

Mr. Clark.—I second the motion.

Secretary.—The following cities have been nominated: Los Angeles, Winnipeg, Montreal, Detroit and St. Louis.

The first three ballots resulted in Detroit, Montreal and Winnipeg losing out in the order named. After considerable discussion as to the advisability of meeting at Los Angeles, the nomination of that city was withdrawn, leaving St. Louis as the meeting place for the convention in October, 1911.

Mr. Rettinghouse.—I move that we suspend the rules, and that St. Louis be named as the place for the next meeting, without the necessity of another ballot.

Motion seconded, and St. Louis selected.

President.—Next in order is the election of officers. The secretary will again read the report of the nominating committee. (Report read.)

Mr. Stannard.—I move that we suspend the rules, and that Deacon Patterson cast one ballot for the election of the officers as named.

Motion carried.

President.—The officers, as nominated, are elected, there being no opposition. The next thing in order is the installation of the officers. The new officers will please come forward.

The new officers were installed, and Mr. Rettinghouse took the chair and outlined briefly the work for the coming year.

Secretary.—We have a report from the committee on resolutions as follows:

REPORT OF THE COMMITTEE ON RESOLUTIONS.

Denver, Oct. 19, 1910.

To the American Railway Bridge and Building Association:

The committee on resolutions respectfully submits the following report:

Resolved, that the thanks of this association be extended to Mr. A. J. Spengel, chairman of the board of supervisors of Denver County who, in behalf of the county and Denver City so ably addressed the convention and so heartily offered us the freedom of the City;

To Mr. S. F. Dutton, proprietor, and Mr. F. W. Paget, manager of the Albany Hotel, for their excellent treatment of the members and their families;

To the daily press for their interest and reports on our proceedings;

To Mr. W. M. Camp, editor of the Railway and Engineering Review, and Mr. H. H. Simmons, associate editor of the Railway Age-Gazette, for their attendance and helpful interest during the meetings;

To Mr. H. Rettinghouse, and Mr. W. M. Camp, for the papers which they prepared and read at this convention;

To the Chicago & Northwestern Ry., Union Pacific R. R. and the Pullman Co. for special train service from Chicago to Denver;

To the Colorado & Southern Ry., for special train service for side trips in the vicinity of Denver and Colorado Springs;

To the various other railroads which provided transportation for our members and their families to and from the convention;

To the members of the Railway Supply Men's Association for their interesting efforts to entertain our members and their families;

To the committee on arrangements, consisting of Messrs. W. T. Powell and James Parks, for their successful efforts in providing hotel accommodations and special features of entertainment during the convention;

To the officers, the members of the various committees, and other members who so generously contributed their time and efforts in making this one of the best conventions in the history of the Association.

Jas. Stannard,
J. M. Staten,
Committee.

Mr. Gumphrey.—I move that the report be accepted.

Motion seconded and carried.

President.—Is there any further business to come before this convention? If not a motion to adjourn is in order.

Mr. Eggleston.—I move we adjourn.

President.—It is moved that the convention adjourn to meet in St. Louis on the third Tuesday in October, 1911. All in favor will signify by the usual sign.

Motion carried.

President.—We stand adjourned.

Meeting adjourned at 12:00 M. Thursday, Oct. 20, 1910.

ARTHUR HANSON, Stenographer.

C. A. LICHTY, Secretary.

SUBJECT No. 1.

METHODS OF PROTECTING EMBANKMENTS AGAINST CURRENTS AND RESTORING THEM WHEN WASHED OUT.

REPORT OF COMMITTEE.

If a sufficient number of openings were left in embankments and the structures built in a workmanlike manner, railroads would not be so liable to washouts. They are now, and have ever been, too much inclined to reduce openings. In many instances serious washouts occur because ordinary trestles have been built where there should have been larger clear waterways. In trestles the bents may be of piles, well driven, but should there come an accumulation of drift, the earth may be scoured from around the piling, and cause the bridge either to be washed away, or the flow of water retarded and a washout occur at the approach of the trestle or other point, and frequently rise to flow entirely over the roadbed on either side of the structure.

In addition to this, a stream that frequently gives trouble and causes serious delay to traffic may overflow and fill in the land on the upper side of the road. If this condition is allowed to continue a few years it may become necessary to raise the track in that vicinity, particularly if the soil is of a sandy nature.

When several panels of a trestle are washed out and it is desired to pass trains quickly, a good plan is to point piles and work them into the soil with cant hooks. When all the piles have been set and braced, place sash near the grade and jack them in. After all of the bents have been placed in this manner, with the track standing sufficiently high to allow for settling, run empty cars over the structure to settle it, and then block up. Then run over the loads, after which allow the engines to cross, but the first engine should not move faster than ten miles per hour.

Work done in this manner will require close attention until piles can be driven. Frequently such a temporary structure can be built and traffic resumed before a pile driver can reach the defective point. The piles for this temporary structure can sometimes be cut from woods near the washout.

It is again often the case that culverts are placed under roadbed sufficiently large to carry the water, but they become choked with drift and the fill is blown out. Such danger can be obviated by making the opening larger. We, of course, realize the importance of removing or burning any brush or obstruction at or near the mouths of culverts or trestles as often as such accumulations occur.

We will now pass to consideration of the case where high water has washed out the roadbed and the track has been carried from the fill. Where the fill is low and the track is not turned over, it can readily be lined back to its original bed without taking it apart; but, if the track is turned over it is cheaper to first remove the ties from the rail. In that event have the ties placed on the roadbed and the rail moved to one side by lifting it with a large force and dropping it upon the ties without uncoupling.

The most difficult problem encountered in such a case is in separating the ties from the rails. A good plan is to cut poles 10 to 12 feet long, and, using them as levers, pry off the ties. This method has been made use of quite successfully.

It frequently occurs when the roadbed is badly washed that water is encountered too deep to crib, but temporary bents may be placed in such holes to advantage. This difficulty occurs particularly where there is a large river to contend with.

Should the water carry the track from the roadbed and it lodge against trees it should be floated back to its original bed while the water is up, if possible. It may be pulled in by a hand crab or with an engine.

Where the overflow occurs frequently the track should be raised above the danger line. Until this can be done the trestle should be securely anchored and the track ballasted with heavy stone or slag. If it is not possible to secure either kind of ballast, a Bermuda sod is very good. The track also should be anchored at such points. This can be done by driving piles alternately 30 feet apart. A very cheap and effective way is to bore holes near the ends of the ties alternately 30 feet apart, and drive a 1¼ inch bolt into the roadbed, leaving the nut on the upper side. The work of driving can be done from a push car.

Where bad washouts have occurred and much cribbing has to be done, a steam derrick is one of the handiest tools obtainable for loading timber and placing it on the roadbed, particularly so if the timbers are long and heavy.

A wash or slide may occur at the side of a fill or near the mouth of an opening. Such trouble is frequently due to the manner in which water is permitted to strike the opening, and it can frequently be obviated by changing the current. Should it not be practicable to change the water course where it runs parallel with the roadbed it may be riprapped with heavy stone. In such a case it is a good plan to dig a good foundation two feet below the surface, begin the wall in the ditch and run it up at a slope of 2 to 1. The bottom of the ditch or channel should be floored with heavy stone. Such construction will frequently answer the purpose of a concrete wall and can be built much cheaper. A wall should be used at the ends of all trestles that are subject to wash.

In cases where slides have occurred, caused by the current undermining the roadbed, and rock can not be secured, it is advisable to drive piling at the lower edge of the fill and begin a wall of timber well under ground. Timber of 12 x 12 inch size should be placed on the side of the piling nearest the track. This construction will hold securely until the timber decays.

If the earth is of prairie formation it is subject to cracking during dry weather, and when the rains begin the water is absorbed by the cracks, and if the fill is inclined to slide, from any cause, it is more liable to do so after heavy or continuous rainfall. This can be prevented by ballasting and spreading the ballast to the slope from the ends of the ties to the outer edge of the fill. A spread of four to six inches, to retain the moisture, is required. The cracks will not occur where the sun is kept from the earth. Clay or soil of a sandy nature will answer when ballast can not be obtained.

If the fill is of a sandy nature the entire embankment is inclined to wash, but if a spread of four inches of cinders be placed on the fill to the edge of the slope, on either side of the ties, the bank will not wash at all on top and not nearly so bad on the sides. The falling water, being absorbed by the cinders does not flow down the sides of fills with such force.

When the track is placed back on the roadbed and trains begin to move, the pile driver should begin work to replace temporary trestles. Slag or stone should be used to ballast the track and fill up small washes, but if neither stone nor slag be available, the next best material with which to surface is clay. The timber used for cribbing should be removed as the track is surfaced.

Where heavy drifts of debris accumulate against a trestle or piers a derrick car with a wrecking crew can be used advantageously; in fact much more

satisfactorily than an engine with block and fall. In removing drift to relieve a structure it is sometimes advisable to use dynamite. Where heavy washing or scouring is being done by the currents and rock is not available, use bags of sand freely, as they can frequently prevent bad breaks in the roadbed.

There are cases where nothing in the way of a temporary trestle would be advisable, and piles must be driven with extension drivers from both directions. Where there is no water to interfere, frame bents should be erected in addition to driving piles; but if plenty of 12 x 12 timber and cross ties are conveniently at hand cribbing can be used to advantage. The foundation for cribbing should be built of 12 x 12 timbers or stringers, and placed so as not to interfere with the driving of piles after the traffic has been resumed. This can be quickly and effectively done by building pens. Bents can then be driven between the pens. Again, if there is a sufficiency of long 12 x 12 pieces, use them after getting the foundation timbers in. This can be done quickly, particularly if the timbers are handled with a derrick car.

When a bridge is found to be settling due to scour under a pier it is necessary to drive a bent on either side of the pier as quickly as possible. After getting two bents in on either side and the bridge seated on the timbers and bolted, the trains can be passed with safety until the pier is reset. If it be not possible to drive piles, place false bents until the settling can be stopped, after which drive the piling as directed. Sand bags or stone dropped around the pier frequently prove beneficial.

Should a wash or slide occur on one side of the roadbed, where the bank is still good on the opposite side, and the track cannot be lined over far enough to carry the trains, drive piles eight feet apart near the rail and place a 12 x 12 timber on the piles longitudinally under the rail, to support the track.

Mr. J. C. Haugh, Resident Engineer of the New Orleans & Northeastern R. R., furnishes photographs showing method of protecting the embankment along the shore of Lake Pontchartrain against storm waves from the lake, a distance of about twenty miles, which was originally a pile trestle and later filled by means of a floating dredge which was operated on the opposite side of trestle from the lake. The material used in filling was composed of shells, sand and marshy soil. (See Fig. 9.)

The piles vary in length from 26 to 40 feet, depending on the depth of the water. They are driven about 16 in. centers and on a line 100 feet from center of the main track. Spacing the piles 16 in. centers allows 4 to 6 inches between the piles from the surface of the water to the bottom of the water. The storms beat more or less sand and shells between the piles and material filling has resulted. In addition, the space allows the waves to break, and part to go through, whereas a solid wall would cause the waves to fall back and undermine.

The piles are cut off 8 ft. above low water. The driving is done with a "creeper," or land driver, and the overhang is some 18 feet. Every 18 feet two outside piles are driven and temporarily capped to carry the driver. The cost for driving is 15 cents per foot of pile. Some of these pile butts show "cat faces," or scars, from cutting for turpentine. These are very rich and resinous, and extend down two feet and over, and as the piles in the water are always wet, but little decay has resulted in some fifteen years.

Considerable trouble had been experienced with sliding embankments of the Yazoo Canal along the tracks of the Alabama & Vicksburg Ry., at Vicksburg, Miss., prior to 1876. This embankment was the east bank of the Mississippi river, the stream in that year having changed its course southwestward one and one-half miles. This embankment is about 40 feet above zero water and apparently has a sub-drainage during the low stage of the river, causing the bank to slide. A method for stopping the slide, suggested to us by an engineer of the United States Government was to drive piling close together in rows, these rows being at least 50 feet apart; but this method failed in its purpose. Fig. 1 partially shows the failure of the plan. Later it was decided to drive piling in a manner similar to that of foundation

work, spacing the piles from 4 to 6 feet apart in all directions, which has stopped the slide altogether. We have been unable to drive all the piling, however, on account of the low stage of the water. When the proper stage of water will permit, we will drive the balance of the piling to complete the work as planned. We have driven in this slide about 1,400 piles 35 to 40 feet long.

Fig. 2 shows a new slide developing further down the river, with piling driven to check the same. For this work a floating pile driver equipped with a No. 1 Vulcan steam pile hammer, was used, weighing 10,500 pounds. The piles were driven with the butt ends down, which offers more resistance and strength at the bottom of the slide where it is most needed. The driving of 40 or 50 piles constituted a day's work.

Figures 3 and 4 show the effect of high water on the Alabama & Vicksburg Ry., washing out many holes 10 to 150 feet long, and from 1 to 10 feet deep. The track was washed off the embankment at a number of places, but it was restored by lining it back and cribbing the holes with track ties, using 12 x 12 pieces for stringers.

Fig. 5 shows a trestle washed off the right of way. This was originally a pile bent trestle, and later when the piling became decayed it was replaced with frame bents. This washout was repaired by setting up new frame bents on the old pile foundations, using 12 x 12 timbers for temporary stringers.

Figures 6 and 7 show approaches to a span bridge washed out and repaired. One approach, as in Fig. 6, was repaired by standing 12 x 12 timbers on rock bottom, capping and bracing the same for bents. The other approach (Fig. 7) was repaired by cribbing with 12 x 12 sticks under the end of the trestle approach and in a section of the hill that was washed out.

Fig. 8 shows a method used by the Vicksburg, Shreveport & Pacific Ry. in building a levee with sand bags to protect the track against high water, this being the one often used for protection of embankments and toes at the ends of trestles and bridges. This shows a plank retaining wall back of the sand bags, which was built to protect a lean embankment, and for the purpose of holding the sand bags from sliding down the slope.

Concrete Protection Work.

J. W. Wood of the Atchison, Topeka & Santa Fe Ry., at Needles, Cal., writes as follows: The use of concrete for the protection of approaches to bridges and on embankments is quite old, but the method used on the desert in applying or putting on the concrete is, I think, both original and very much cheaper than the older methods. The photographs show a single piece of work as an illustration of the method used in the work here. By doing away with the use of forms we save, in the desert country where we have proper sand and gravel in the wash, 50 per cent of the labor cost of placing the concrete.

The illustrations show a concrete wall at Hackberry, Ariz., which is 1,600 ft. long. The wall is twelve inches thick at the top, four feet thick at the bottom and is thirty feet and six inches in height. The bottom of the wall is placed six feet below the level of the wash. The concrete is reinforced with wire mesh made of No. 8 wire, which has a six-inch mesh of No. 12 cross wires. (See cuts, pages 61, 62.)

Our method of construction in this case consisted of first digging a trench six feet below the wash level, the work being done with teams and scrapers, and building an embankment eight feet high. This bank has a slope of 1½ to 1. The mesh was spread over the embankment and tied together with the No. 8 wire running horizontally. Three by ten spacing forms with a six-foot space were then placed from the bottom of the ditch to the top of the embankment, being tied together at the bottom with 1 x 6 in. strips and resting on 6 x 8 in. pieces at the top of the embankment, care being taken to give them the proper alinement. On

the top of the embankment a track was laid on which was operated a truck consisting of bridge stringers placed on standard car wheels. A concrete mixer was placed on one end of this truck and a steam hoist on the other, water and steam being piped from a pumping plant close at hand. On this truck a gallows frame was placed directly over the mixer, and from this frame a taut cable was stretched to a point about 100 ft. into the center of the river bed, where good sand and gravel was to be had. On this cable a metal bucket, holding about ten cubic feet of sand and gravel and attached to a traveler, was operated. This bucket was filled from the wash, was hoisted on the cable to a point over the hopper prepared on the mixer and the contents dumped into the mixer through a trap on the bottom of the bucket, the proper measure of cement being put in at the same time. The mixture was handled after it left the mixer by gravity, being conducted to the bottom of the fill in a trough. Each alternate space between the spacing forms was filled, the wire mesh being pulled to the center of the concrete mass with iron hooks. The concrete was tamped after the mesh was placed in the center and was then leveled with skids reaching from one spacing form to the other and finished with trowels. The spacing forms were then removed and the remaining spaces filled in and leveled by skidding from the face of the blocks already in. Care was exercised to see that the spaces between the blocks of concrete were filled in daily. The embankment was thoroughly saturated with water, to stop suction, and the concrete was kept thoroughly wet after being applied for about ten days. The above work has resulted in a monolithic mass of concrete which shows a very small number of cracks, and these are evenly distributed, tne concrete being firmly held together by the mesh reinforcement.

At points where the action of the water is not so severe we protect the approaches to our bridges by putting in a wall six inches thick on the bank slope. We dig a trench eighteen inches wide to a point below scour line, or to hard pan, placing the wire mesh in the center and filling in with concrete to a point about the level of the wash. We then turn the mesh back on the bank slope, using 3 x 6 in. form spacers, as before described, and fill this in with concrete, beginning at the bottom, pulling up the mesh to the bottom of the 3 x 6 in. pieces, this being the center of the concrete, and finishing as above described. Work of this class is usually done by hand mixing, as we find that it is more economical than to take on the expense of loading and unloading the concrete mixers.

E. L. Loftin,
O. T. Nelson,
Committee.

Fig. 3. Slides in Front of A. & V. Ry. Property at Vicksburg, Miss.

Fig. 2. Slide in Front of A. & V. Ry., Property at Vicksburg, Miss.

Fig. 3. Washout on Alabama & Vicksburg Ry.

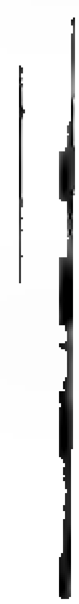


Fig. 5. Washout on Alabama & Vicksburg Ry.

Fig. 7. Temporary Bridge Work, on A. & V. Ry.

Fig. 8. Building a Levee with Sand Bags, Vicksburg, Shreveport & Pacific Ry.

Fig. 9. Embankment Protection for N. O. & N. E. R. R., Lake Pontchartrain.

Concrete Embankment Protection, A. T. & S. F. Ry., Hackberry, Ariz.

Method of Construction of Concrete Embankment Protection,
A. T. & S. F. Ry., Hackberry, Ariz.

DISCUSSION.

H. Rettinghouse.—The report is certainly very complete and the illustrations look familiar to me; they remind me of bygone days. I have had some experience along the Missouri River, which is undoubtedly one of the worst to contend with in this country. The Chicago & Northwestern Ry., the Union Pacific and the Burlington roads have to battle with the Missouri, and not only the railroads but the United States Government finds that protection to banks along that stream by driving piling is entirely useless; it will only aggravate conditions instead of bettering them.

The only effective way to protect banks of the Missouri, as well as the Mississippi, is by placing mattresses from the bank some distance into the river, and loading them down with stone. During the last two years, at Sioux City, where the embankment was about 20 feet above the river, it began to slide, and as I had no experience, I suggested the driving of piling; but I was informed that it was not effective. At a consultation with the government engineer in charge, we finally decided to put in mattresses. The work was done during the winter, and it stopped the slides at once, and there has been no trouble since.

The C. & N. W. Ry. has an important bridge across the Missouri river at Blair, Neb. As you all know, the Missouri river is very troublesome, changing its bed continually, and protection work of that kind becomes necessary every year. I dare say that our company has spent something like $50,000 every year at that bridge alone. I have no jurisdiction over that part of the line, but it is very close to my territory, and I am much interested in it. I am sorry that the people in charge of that work were not reached by the committee, and, in fact, all the companies having roads along the Missouri river could have furnished valuable additions to this report. I believe the subject is of great interest, and I think that it should be continued another year.

Mr. Staten—I have had a good deal of experience with washouts. We have a road running 230 miles along the James river, and I don't know how many times the track has been washed right off the fill. Sometimes the water will rise high

enough to wash the track off the embankments and turn it upside down. When it does this it usually washes the far side of the bank before it will tip the track over.

We tried an experiment by driving some small piles, two to each rail. We drove these down and then bored a one-inch hole through the tie, and put a ⅞-inch bolt through the tie to the pile. I think we have fixed about three miles like this. We have found this a cheap and substantial way of holding the track, and we have been trying to put in more rock to make it more secure.

Mr. Scribner.—The Missouri Pacific and the St. Louis, Iron Mountain and Southern roads which are operated as one system, have both the Missouri, and the Mississippi, as well as another river, which are in the habit of disregarding railroad rights. They have given us so much trouble that we have an official appointed, with the title of "engineer of river protection." The general proposition is to protect the banks with willow mats, weighted down with stone. Another method, which is used to some extent, is to build a sort of guard where the current strikes and throw it off. Mr. Miller, our engineer of river protection, was employed by the government previous to his employment by the Missouri Pacific, and he has had a great deal of experience in this line of work.

Mr. Penwell.—The discussion has been about large washouts. One thing I would like to mention is that we sometimes overlook the small things. There are many places where washouts could be prevented by planting trees in order to protect banks. In most cases willow trees will grow well and form a good protection. I make a motion that this subject be carried over and again be placed on the program, and it would be well for the committee to remember the men who have had experience in this line and call upon them for information.

Mr. Killam.—Last year, in a certain valley, we had a cloudburst, and it washed out a large portion of the track. The trackmaster on that division was a very active man; he went there with his pile driver, drove some piles, and put in some stone, and thought he had it secure. A short time afterward there came another storm and took out some 700 feet of track. He again drove piling and put in brush, and then put in large flat stone, some of them weighing four tons. They were loaded with steam derricks and put in, I think, for nearly a thousand feet.

He laid these large stones on top of the brush, put in a little crib work, and made a perfect roadway, and I guarantee that in the next thirty years there will be no more trouble there. Brush, I claim, is the essential of the whole matter of preventing washouts in soft ground.

Mr. Parker.—It might be interesting to the members to know what we have to contend with in Southern California in the way of washouts. Some people say our rivers are bottom side up, but nevertheless, during heavy rains, in the winter time, tremendous bodies of water come all of a sudden and as soon as the rains are over, in a few hours the water is gone. When washouts occur on a high fill we put a pile driver at each end and build "shoe flies." In our protection work we use different methods, including concrete protection walls. We had considerable trouble last winter with the San Barnardino river. In one case we put in cribbing and got the trains running, and then built concrete protection walls, down about six feet below the surface of the river. Mr. Penwell has mentioned the plan of planting willow trees. In a great many places we have done that. In a few years the ground gets thoroughly filled with roots and they form very good protection. They grow very readily, and soon get into the ground pretty solid.

Mr. Lichty.—I would like to see this subject continued; I know there is more information on this subject under way and I will second Mr. Penwell's motion that we carry this over another year. This report, however, should be printed in this year's proceedings.

Motion carried.

Subject No. 2.

CAST IRON PIPE CULVERTS.

REPORT OF COMMITTEE.

The subject assigned this committee is "How to Prevent Iron Pipe Culverts from Pulling Apart in Soft Ground, and How Best to Repair Them When Pulled Apart."

A large number of requests for information were sent to the members and 87 replies were received, indicating much interest in the subject, which is an important one.

A large number would take great care in putting in a substantial foundation for the pipe, using old bridge timber for grillage and a cradle, or a concrete foundation the whole length of the pipe, or concrete piers under the joints, thus practically avoiding the danger of pulling apart. Various methods were suggested for repairing broken pipe or joints that were pulled apart, some using rods with turn-buckles, or with a long thread, to draw the pipes together. Many, however, advocated digging the pipe up and relaying, or digging down to the joint and repairing with concrete.

We agree, therefore, that whether or not all of the letters that have been included in the appendix should be published, the information contained in the majority of these letters should be made available in that manner for the benefit of the members.

Many of the replies are particularly interesting, giving accounts of valuable experiences and suggestions, and the committee desires to express its appreciation and to thank all contributors for their assistance.

A. A. Page, (Chairman),
J. S. Browne,
W. H. Moore,
F. C. Rand,
R. O. Elliott,
H. C. Thompson,
Committee.

APPENDIX.

Joseph T. Richards, Chief Engr., M. of W., Penn. R. R.—We would not lay iron pipe culverts in soft ground without introducing a pile foundation, where necessary, or a concrete invert where the same will answer the purpose. I can give you no advice as to the best method of repairing the same where pulled apart, but probably the best thing to do under these circumstances would be to tear out and relay the culvert. It might be possible to tunnel into the bank and surround the separated joint with a collar of concrete, but this would probably prove to be only a temporizing arrangement.

W. C. Cushing, Chief Engr., M. of W., Penn. Lines.—In placing cast iron pipe 24 inches or more in diameter, build under each joint a block of concrete, 12 inches thick, 24 inches wide, and 48 inches long, parallel with the track. The pipe should be laid in position before the concrete is placed, so that it will get a good bond on the hub of the pipe. The ground around

the pipe, for its full length, should be carefully tamped. We recommend that where pipes are put in under tracks in service the stringers supporting the track be left in place for several months, until the ground has become well settled around the pipe, before the full weight is thrown on it.

In slips, the best method of holding the pipe in place is to carry the small concrete piers to the bottom of the slip, if this is not too deep. In cases where the slips have been deep, we have driven pile foundations, three piles in a row, spaced 2 feet on centers, parallel with the track, and spaced 4 feet center to center parallel with the pipe. The top of the piles were concreted and the pipe laid on the concrete. Where a culvert in a slip was

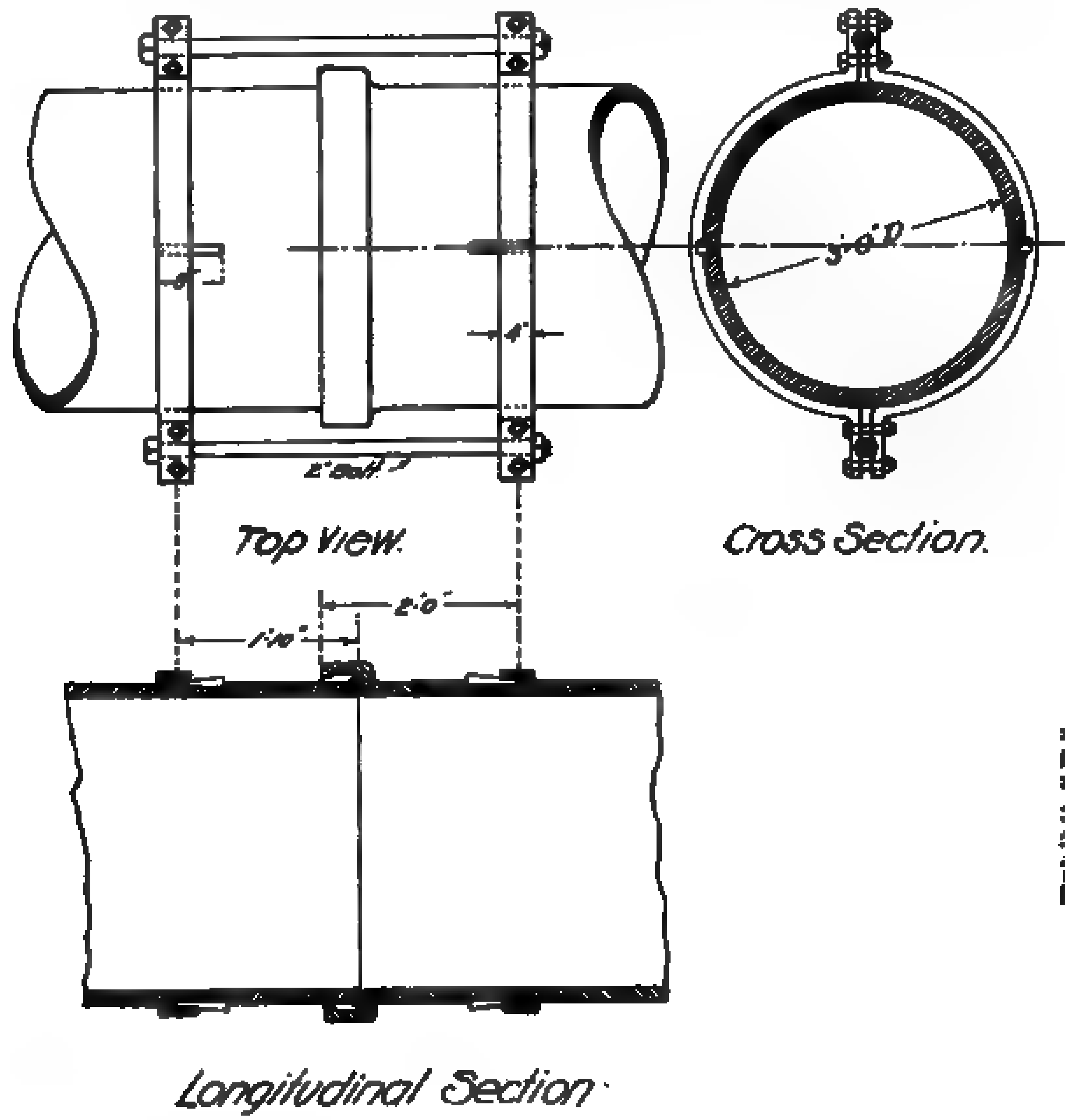


Exhibit "A."

treated as above, in 1907, no movement has since occurred, either in the pipe or in the slip.

M. M. Barton, Penn. R. R.—I have laid one 4 foot and one 6 foot (diameter) cast iron pipe in 12 foot sections in the bed of the drainage canal, where there was a soft mud or muck bottom. In these cases we constructed a raft of old trestle timber the entire length of the culvert, with a bolster or cradle spiked on the raft for the pipe to rest in and keep it in line. We then floated the raft in place under the roadway, anchoring it to the pile trestle bents which support the track. After it was secured in position we laid the pipe at low tide and followed with the fill. The 4-foot pipe has been in about

Exhibit "B."

seven years and the 6-foot pipe more than three years, and both are in good condition.

R. G. Develin, Asst. Engr., M. of W., Penn. R. R.—Our tracks along the Monongahela river seemed to move toward the river and separated a 24 inch pipe culvert. It was put back and clamped as shown on "Exhibit A" and has served the purpose. We had some trouble at another culvert which pulled apart, owing to the settlement of the fill and the pipe not being properly supported. We dug down around the joints of the pipe and concreted around them, we also built parapet walls at the ends. All pipe in a fill should be laid on a bed of old ties, to insure a good bearing.

We have never had any experience with iron pipe culverts pulling apart in soft ground, but I think the trouble could be corrected by putting an iron tie clamp on top of the pipe, drill holes through the bell and spigot ends, and then fasten this tie clamp with bolts. If the pipe pulled apart enough to allow the spigot end to be out of the bell, I do not think good repairs could be made without taking the ground off the pipe and putting it back in place. If the pipe had not been pulled apart far enough to allow the spigot to be out of the bell, my method of repairing would be to bolt some tie pieces across the joints to keep it from going any further and then fill the open spaces with concrete. We have two 72 inch pipes where the ground is soft, and we put two piles capped with 12 x 12 inch timber at the joints, which has given good results.

If pipes pull apart in soft ground, the only way I can see to hold them in position would be to remove them and place a good solid foundation at the joints. If I had a case of this kind I would pull the section together by placing timber across each end of the pipe and use strong iron rods with threads on each end, and by tightening up the rods I believe I could get the pipe back into position. To hold them in place I would build a concrete wall around and over the end of the pipe of sufficient depth to resist any movement.

On the mountains, or where our pipe culverts have much of a fall, we clamp them together with three clamps, these being about 3 x ¾ x 16 inches, as shown on "Exhibit B." We do not put any clamps on the bottom of the pipe, as we want to leave the bottom surface as smooth as possible. We have been doing this for some years and have had no trouble with our pipes pulling apart.

D. C. Zook, Penn. Lines West.—Our method, where the ground is only moderately soft, is to lay a floor of track ties at right angles to our pipe, placing the ties as close together as possible, to form a bearing of about 8 feet width. On this we lay our pipe, on a saddle of square timber made by placing a piece on each side of the pipe and resting on all the ties. These pieces of timber are chamfered so, to conform to the curvature of the pipe as nearly as possible. We usually, when the pipe is 3 feet or more in diameter, use a piece of timber about 12 inches square.

When, in our judgment, the ground is too soft to allow this mode of construction we drive two-pile bents at about 6 feet centers, our pipe being 12 feet long. We cap those piles and on this foundation lay our pipe, supporting it between bents with the saddle already mentioned made of 12 x 12 inch timber fitted up to each side of the pipe and securely fastened to the cap. The object of the timber is to afford additional bearing to the pipe and prevent it from crushing.

We have already obtained good results from these methods and have never had any trouble where they were used, although when we first began using cast iron pipe for this purpose we had trouble with our pipes sinking, as they were not supported other than by earth. We then had to dig them out and support them, as I have indicated.

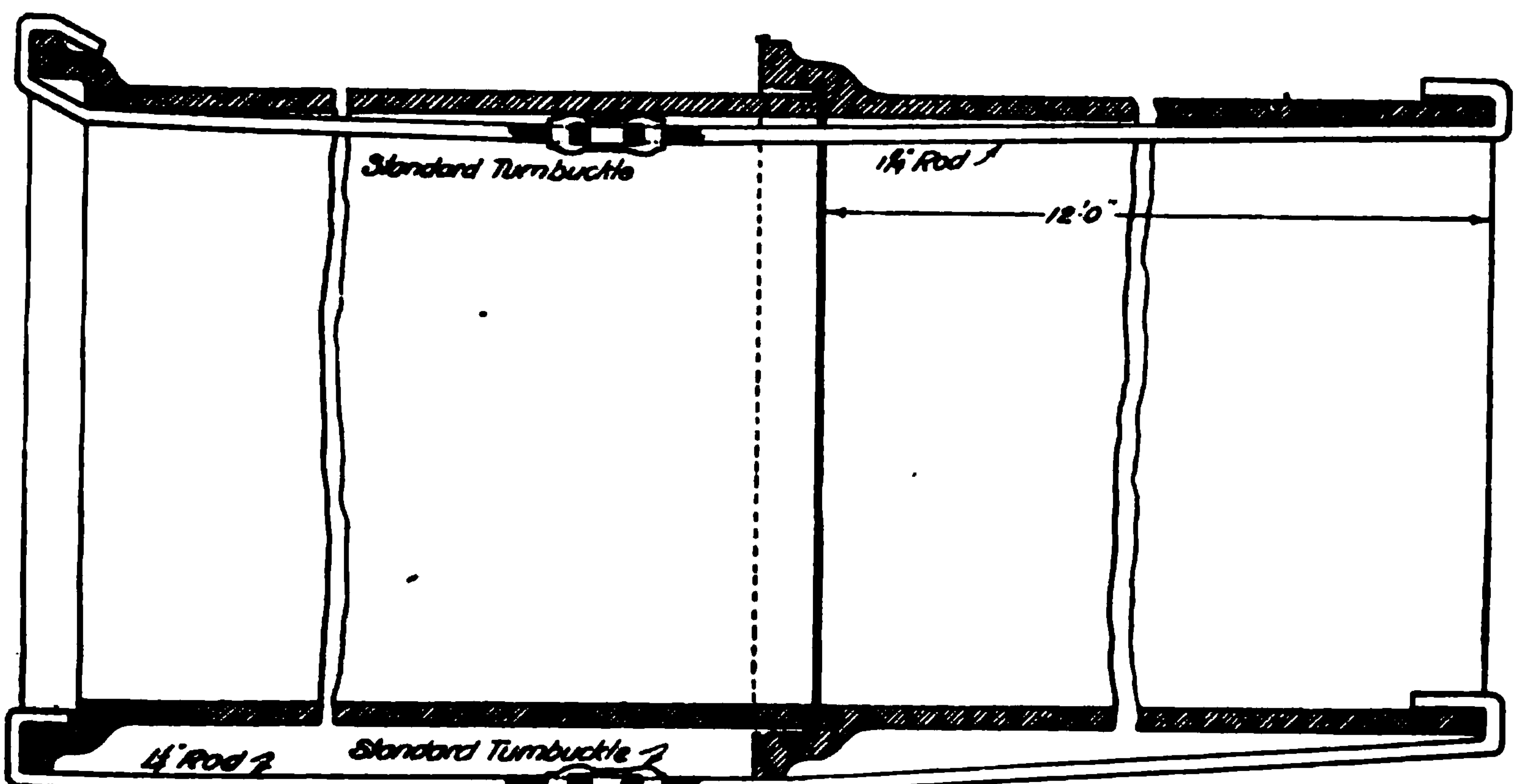
S. C. Bowers, P. C. C. & St. L. R. R.—For any cast iron pipe 24 inches or more in diameter we put under each joint a block of concrete 12 inches thick, 24 inches wide, and 48 inches long, the latter dimension parallel with track. The pipe should be placed in position before the concrete is put in, so that the concrete will get a good, hard bond on the hub of the pipe. Care

should be taken in laying the pipe, in all kinds of ground, to tamp up under it the full length.

My opinion is that most of the pipe that goes out of position does it before the ground gets thoroughly settled. This happens more frequently where the pipe is near the surface of the ground, and the longer the stringers are left in the track the better it is for the pipe, as it gives the ground a chance to settle before all the weight is thrown on them. Where it can be done pipe should be laid during March or April and the stringers left in until July. This plan will save considerable tamping for the section men and still give them time to get their track in good shape for fall inspection.

In slips the method of holding pipe has to be determined by the depth to terra firma. On this division we had a case of pipe pulling apart in a slip where solid ground was about 6 feet below the bottom of the pipe. In this case we excavated down to the rock and into it about 6 inches and built up small concrete piers under the joints. The pipe had pulled apart about two feet before this was done. The work was done early in 1908 and there has been no trouble since.

Where the slip is too deep to excavate, piles should be driven, three in a row, 2 feet on centers parallel with track and 4 feet on centers parallel



Method of Clamping Cast Iron Pipe Together Longitudinally, Where Liable to Pull Apart, as Used by Several Roads.

with pipe. Then concrete should be placed on top of these and the pipe laid in the concrete. This method was used in 1907 at a slip on this division and there has been no movement since. This is not only a preventive from pulling apart but also keeps the slip from moving.

B. F. Gehr, P. C. C. & St. L. R. R.—My experience with laying cast iron pipe in soft ground is to place a cement pier just back of each bell; and, if under a heavy fill, also at the center of the pipe section, on a uniform grade. If the soil is such that it is necessary to build cement piers and there is still fear of settling a small amount under the track, it is well to leave the line of pipe crowning in the center. In addition, holes may be drilled in ends of the pipe and ¾ inch rods may be run through from the inside and bent over on the outside. I would use four clamps at each joint for a 3-foot pipe and more or less according to the size of the pipe. This arrangement will prevent the sections from pulling apart.

A good method of repair when pipes are pulled apart is to draw them together with a steamboat ratchet or screw buckle.

W. Renton, B. & O. R. R.—We had one pipe culvert with pile foundation settle to one side on account of soft ground on that side and solid

ground on the other. We had to uncover it and couple up the pipe, which was thirty-six inches in diameter, and after we got it in place we used a 2½ inch rod 60 feet long, running it through the pipe and anchoring it at each end. Another culvert settled and the pipe pulled apart. We put it back to place on a concrete foundation and then buried it in concrete. Have had no trouble with it since that was done.

We have laid cast iron pipe culverts in soft ground on timber foundation, ten or twelve feet wide and the full length of the pipe. We generally use for this purpose second-hand bridge timber. Water covering the timber prevents decay.

D. B. Taylor, B. & O. R. R.—The method I have used in clamping the pipes together is, by using a hoop shape made either of round or flat iron, size 1¼ inches for 24 to 36 inch pipe, with three or four eyes in this, equal distances apart, placed on the extreme upper end of the culvert. Have this hoop shape made the exact size of the large part of the bell end of the pipe, and then similar hoops made to be placed below each of the bell ends of all the lower joints, to fit the outside of the pipe neatly, with six to eight eyes in them for the rod connections. The rods have threaded ends with nuts, to be tightened with a wrench and equally adjusted.

In regard to the question of how to best repair when the culvert pulled apart: Make a flat iron band similar to the round iron, with a suitable number of eyes. Place this on the pipe that is permanently located under the fill and drill three or four holes through the same. Put in a short button-head bolt with nuts on the outside. Use the rods from the eyes to below first bell in similar bands with eyes, and so on until the last end. Then use a hook or the bent lower ends of the rods to catch on to the spigot end of the sewer. Adjust all of the rods in this way, to get equal weight on the same. This will prevent the pipe from parting.

S. C. Tanner, B. & O. R. R.—In my experience I have had very little difficulty in this line, and only recall one instance where the cast iron pipe pulled apart. This was a 24 inch pipe under double track, on the glades of the Alleghany mountains, where the fill was soft, and the pipes separated about 12 inches. To make repairs, we dug down to the joints and placed a form in the pipe and incased the joint with concrete and then built a small head wall at each end of the pipe which took care of the situation. The expense was less than $100, as there was not much of a fill above the pipe.

On nearly all of our cast iron pipe culverts we use a head wall, with wings on the intake end, and believe that this is one reason that we do not have any more pipes pull apart than we do.

However, I believe, that where pipe is liable to pull apart it is well to use a small-size rod extending from one end of the culvert to the other, on the outside of the pipe, and hook it over the ends of the pipe, with a turnbuckle in the middle. Such a device clamps the pipes together and prevents the sections from pulling apart.

R. H. Reid, L. S. & M. S. Ry.—Where we have placed iron pipe in extremely soft ground we have sometimes driven piles on both sides of the culvert line, capping these piles crosswise under the pipe, just back of the bell, so as to form a two-pile bent under each 12 foot section of iron pipes; or, if the conditions warrant, we put two bents of two piles each under each section of pipe and place the pipe on saddles, the saddles being cut out to fit the curve of the pipe. We then fill in carefully over the pipe. In addition to this, where we have found it necessary, we have placed iron rods entirely through the pipe on the inside, with hooks over each end of the pipe with one or two turnbuckles in the rod for drawing them up tight.

In other cases of soft ground where the conditions have not been bad enough to require pile bents, we have placed old ties or old bridge stringers for saddles and have laid the pipe directly on them, clamping the pipe together with rods, as above mentioned. In one or two cases we have drilled holes in the pipe near the end and fastened the sections together with iron straps bolted through these holes. Where pipe culverts have pulled apart in soft ground, it is generally necessary to dig out one or two sections at each end, depending upon conditions, and close up the joints by resetting the

pipe; and, if conditions seem to require it, place the iron rod clamp through the pipe culvert, as above noted. These methods have given general satisfaction and are still in use.

J. H. Roach, Division Engineer, L. S. & M. S. Ry.—I have in mind a waterway constructed of 24 inch cast iron pipe in soft ground under a 100 foot embankment, and I attach a sketch showing the pipe as actually built.

The character of the natural ground and its action when under heavy loads was well known before the work was started, and on account of the high fill to be placed over the pipe it was deemed necessary to take every precaution possible to prevent the pipe from settling and pulling apart after the fill was completed. Accordingly, 50-foot white oak piles were driven for a foundation and the pipe was encased in concrete reinforced with bars placed longitudinally, to take care of the longitudinal tension likely to result when the fill was made. After the structure was completed the fill for a height of about 25 feet above the pipe was placed in position in layers about 4 feet thick with teams and scrapers, which compacted it well. Later the fill was

Cross Section. Lateral Section.

Method of Laying Cast Iron Pipe in Soft Ground. L. S. & M. S. Ry., (Cleveland Short Line.)

carried up to grade in the usual way, and, although stakes placed in the natural ground north of the north end of pipe showed a movement of about 12 inches to the north and a rise of from one to two feet, there was no appreciable change in the grade or alignment of the pipe.

C. A. Stelle, Div. Engr., W. & L. E. R. R.—We have, on different occasions, used two methods. One has been in use for some time at Fremont, where the filling is settling next to the river. In this we have put a 1¼ inch rod through the 48 feet of 24-inch pipe and a heavy iron bar at each end. We then screwed the sections together. This was done several years ago and the plan has been successful, although once the thread on the rod stripped and allowed the pipe to part. We, however, replaced this rod, and have had no further trouble,

At several other places on our line where the pipe had been placed on soft ground, I have used, in one instance, old car sills, laying about three of these sills in the bottom of the ditch, and placing the pipe on the same, thus providing against one section dropping below the other in case of pulling apart. This method has been successful in two instances, and in a third instance I have used 12 x 12 inch timbers with good results.

J. P. Snow, Chief Engr., B. & M. R. R.—I have never experienced difficulty with pipe culverts pulling apart. For small pipes I would recommend the lock joint pipe, which comes in 4-foot lengths and is cheaper than

bell spigot pipe. For large pipes, if the foundation is such that future movement is feared, I would recommend a timber cradle for the pipe to rest on.

Where pulling has occurred in an existing culvert, if the pipe was large enough for the workman to enter, I would work rich mortar into a ring to fill the space. If the pipe was too small for this I would try grouting the fill with a grouting pump, either from the top of bank or by a pipe with an elbow, worked from the end of the culvert.

J. P. C
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Section of Lock Joint Cast Iron Culvert Pipe.

With concrete heads on these culverts, the foundations of which are carried about 3 feet 6 inches below the bottom of the culvert opening, we have had no trouble. The length, height, and thickness of head walls will of course, depend upon the height of the fill behind the same. Cases where pipes were broken under the track or pulled apart have not bothered us, as I now can recollect, except in places where there have been comparatively low fills. In these situations we simply put temporary stringers under rails, resting on the earth at the ends of sufficient size to carry the load for the opening desired, and after excavating down to the pipe relaid it as outlined above. In deep fills, where extremely long piles would be necessary to make an opening down from the track for such cases, I would advise tunneling from the end of culvert, if it was not possible to remedy the trouble from the inside of culvert pipe.

It may be pertinent to this subject for me to state that, with concrete casings, as described, I have found that tile pipe apparently answers the purpose as well as cast iron, even when the top of the culvert is comparatively close to the ties.

B. F. Pickering, B. & M. R. R.—I have usually found it advisable when laying pipe culverts in soft ground to put some timber cribbing under them, and, if very soft, to drive piles under the cribbing. With such practice I have never had difficulty with the pipes pulling apart. I recall one instance where I put in three lengths of 48 inch cast iron pipe some twelve years

Lock Joint Cast Iron Culvert Pipe, Assembled.

Method of Locking the Pipe.

ago on very soft clay and quicksand bottom. I made a cradle of old turntable timber, some four feet longer than the pipe, leaving 2 feet at each end for a buttress end wall to rest on. This has never given a particle of trouble, but to all appearance is as good today as when put in.

To repair them when pulled apart, I would recommend using a strong concrete mixture, if water can be kept out sufficiently to use the same. Otherwise, I would take up and relay the culvert, either on a timber crib, or have two old rails running the entire length of culvert at the bottom and outside of the pipe, securely fastened to each end pipe.

Fred C. Rand, B. & M. R. R.—I would recommend making a clamp in two places of, say, ½ x 2½ inch iron, for pipe not over 16 inches in diameter, and fasten the clamp around each piece of pipe—one up close to the bell, the other one foot from the end of the other pipe. Take two ⅞ inch rods, with a turnbuckle in each, one on each side fastened to the clamps. It seems to me that this should hold all right.

If the pipes were pulled apart I would use the same idea, simply lengthening the rods to suit opening. Then take a piece of No. 28 iron and make a sleeve, fastening the same together with stove bolts. Cover the sleeve and about six inches of the end of each pipe with about four inches of concrete. This will make a solid job.

Moses Burpee, Chief Engr., Bangor & Aroostook R. R.—The best preventive is a good foundation which will not yield. If this is impossible, the ordinary cast iron pipe is not the material to use for a culvert, as a heavily reinforced concrete one would be as cheap and answer the purpose better. For repairs, it may be necessary to dig out and rebuild, and it may be possible to hold by rods with hooks on ends, and turnbuckles.

H. S. Wilgus, Engr., M. of W., P. S. & N. R. R.—The custom of this road has been to tie the extreme ends of the pipe culverts together with one or more iron rods. We have never had any pull apart.

C. S. Knickerbocker, Engr., M. of W., N. Y. O. & W. Ry.—It has been our practice to put rods the entire length of the culvert, inside the pipe and the same on the outside, to prevent the iron pipe from pulling apart. In this case, of course, the ends are enclosed in concrete, which is part of the parapet wall.

F. L. Stuart, Chief Engr., Erie R. R.—While it is true that no pipe should be put in where the foundations are so soft that it is liable to pull apart, in unimportant work the risk is sometimes taken, on the score of economy. In such cases I think the plan which offers the most hope of holding the pipe together is to lead the joints, put in a gravel foundation, build head walls and tie them together independently of the pipe. My idea is that the tying of the head walls would give some play to the pipe, whereas if clamps were put on at each joint they virtually make a girder of the entire pipe, and a settlement of the embankment will break this girder much sooner than it will open up the pipe with the head walls tied together.

We have had very little trouble with iron pipe culverts pulling apart, but have had several failures which were of such a character that I do not think clamps would have done any good. Water companies use clamps and turnbuckled rods occasionally, at bends in high-pressure lines or at dead ends.

G. B. Owen, Engr., M. of W., Erie R. R.—A grillage placed under the pipe, with a pipe set in concrete, which should be reinforced longitudinally, is as safe a method as can be employed. The grillage should increase in width toward the center, so that when the bank settles the pipe will settle as evenly as possible.

George Sampson, Chief Engineer, N. Y. N. H. & H. R. R.—Wherever possible I would always choose to lay iron pipe culverts on the hard ground adjoining the soft place. Where local conditions are such as to make it absolutely necessary to lay the pipe above the soft bottom, if the soft, spongy earth should be of only moderate depth, say five or six feet, I would lay a cradle of stringers in long lengths and let the pipe rest upon it, assuming that the cradle is designed strong enough to overcome any breaking strain which might be caused by the load above it, and let the pipe rest directly

on such timber cradle with the joints caulked in the ordinary manner. If the depth of soft material were greater, I would drive piles and build a timber cap or cradle of strength sufficient to support the pipe at grade, having the joints caulked in the usual way.

I have had occasion to drive piles and put on timber caps in this way to support water pipes laid beneath tracks on filled land and had good success in keeping the pipes water tight. Previously laid in earth only, the joints had pulled apart sufficiently to make them leaky.

As to making repairs to a broken pipe line, where the joints may have pulled apart, I would be governed entirely by local conditions in each case. Under banks of moderate height, as a general rule, I would dig down from the top, take up the pipe and repair it at the bottom of the trench. If the bank were excessively high and the material of which it is composed, difficult to handle, I would tunnel under it, uncovering the pipe and allowing it to be taken apart and replaced. Possibly in such a case the weight of embankment may have sufficiently compressed the under stratum of soft material so that the pipe might then be relaid on the earth foundation without timber cradle or platform.

While I have never had occasion to do so, it appears to me that if a bed of reinforced concrete were laid beneath the pipe it might be made of use to good advantage as a proper support for a pipe relaid after tunneling.

Thos. L. Dunn, Chief Engineer, Maine Central R. R.—I have put in very few pipe culverts on concrete or masonry foundations. In putting them in on soft ground, I have generally laid the pipe on timber, making a solid bed of ordinary second-hand cedar cross ties 8 feet long. Such a bed is more elastic than masonry and I think the pipes are less liable to pull apart. Ordinarily too, when laying pipe culverts in soft ground the earth is very wet and the timber therefore lasts indefinitely. In two or three instances where pipes have pulled apart, I have simply had the pipes jacked up to grade and thickened up the timber bed under them. Then if they were pulled apart more than two or three inches I have had a short piece of pipe put in and made connection with a sleeve. If pipes were pulled apart but two or three inches, I would put a belt of concrete around the pipe.

Onward Bates, C. E., Chicago,—I remember one iron pipe culvert, laid under my direction, which lengthened under the weight of the embankment placed on it until the pipe ends protruded through the concrete end walls about 6 inches. I think this pipe was about 3 feet in diameter. At another place, where I knew in advance that the culvert would be liable to stretch, I put timbers across the ends of the pipe and held it to length with rods. In this case the culvert was an equalizer, not subject to freshets, but to river rise, so that the timbers were not to be feared as obstructions liable to clog the ends of the pipe. After the embankment had settled, the rods were removed, and I never heard of any trouble with this pipe.

It is frequently the case that settlement and stretching of pipe culverts must be provided for. I do not know any rule to suggest, because the conditions are always local and vary so much that it appears to me the Engineer who plans the culvert should be careful to ascertain in advance the conditions. and to provide for them in such way as seems best to him.

R. C. Young, Chief Engineer, L. S. & I. Ry.—I have seen instances where it was necessary to put in iron pipe culvert on soft ground, and before laying the pipe a foundation was prepared on piling and concrete, the concrete coming half way up the side of the culvert. I think, however, that in such cases it is better to finish out and make a concrete arch complete. I have had two instances where iron pipe failed, one under a 65-foot bank and one under a 95-foot bank. This pipe failed by splitting due to pressure, and we were unable to repair it in any way. We found it necessary to drive tunnels through the dumps and put in concrete culverts to replace the pipe.

Personally, I am not in favor of laying cast iron pipe for culverts except under moderately low fills, and then only where good, hard bottom can be obtained. In the case of swampy ground I usually move the culvert to one side of the depression and ditch to it, if possible. In putting in culverts in hard ground, the bottom should be hollowed out to fit the shape of the

pipe. It should also be excavated under the bells, and the earth should be securely tamped under the pipe before filling over it.

G. A. Wright, Illinois Traction System.—About the best thing to prevent pipe from pulling apart that I know of is to fill the chime of the bell end with good, rich cement mortar, well packed in. This will hold the sections together under ordinary conditions. I have found it necessary, in some places, to put rods from end to end, with strong hooks to reach over the ends of the pipe and turnbuckles to draw them up tight. In some places where one or two joints have been added to the pipe already laid to widen the bank for second tracks or sidings, I have placed these rods on the inside of the pipe. These pipes added for wider fills I have found the hardest ones to hold to place, as the new fill generally slides down the slope of old one and carries the pipe with it.

As to repairing them when pulled apart, I have pulled them back with a heavy chain and steamboat ratchet. In some cases I have found it necessary to excavate down to the top of the pipe and alongside to about the center of diameter, before being able to move them. The rods used were made up in 12-foot lengths, and these sections were coupled together with welded eye. Old bridge rods were utilized for the material.

A. S. Markley, C. & E. I. R. R.—After laying pipe in place fill the bell around the spigot end of the pipe full of grout made of one part cement and three parts sand. Care should be taken that the grout is well mixed and stirred up while pouring, so that the sand and the cement will not separate. Care should also be taken that a clay roll or pipe jointer is held firmly against the bell of the pipe, to prevent the grout from escaping through an open seam. This method has been our practice for the past ten years, and has proved very successful. Previous to using this method, in a good many cases, joints of pipe would partly separate, more particularly those on the outer ends of high banks, until the bead on the spigot end of the pipe would pull apart sufficiently to engage in the groove in bell end. In some cases, very rarely, the ends of the pipe will pull out of the bell, disconnecting the joint.

Where the ground was soft and the pipe likely to settle irregularly and out of line, and cement calking is not likely to hold, I have put three rods of about one inch diameter, depending on size of pipe, hooked over ends of pipe, with turnbuckles in the center of each rod, on the inside of pipe, to pull the sections firmly together before filling. The rods are divided at equal distances apart. If advisable the joints can be grouted, as above explained. After the pipe has thoroughly settled to a firm foundation the rods can be removed.

Where the conditions are such that no good natural foundation can be found at the desired spot, one may possibly be located to one side, where the ground is solid, thus saving the expense of preparing a foundation with concrete or piles, as the case may warrant.

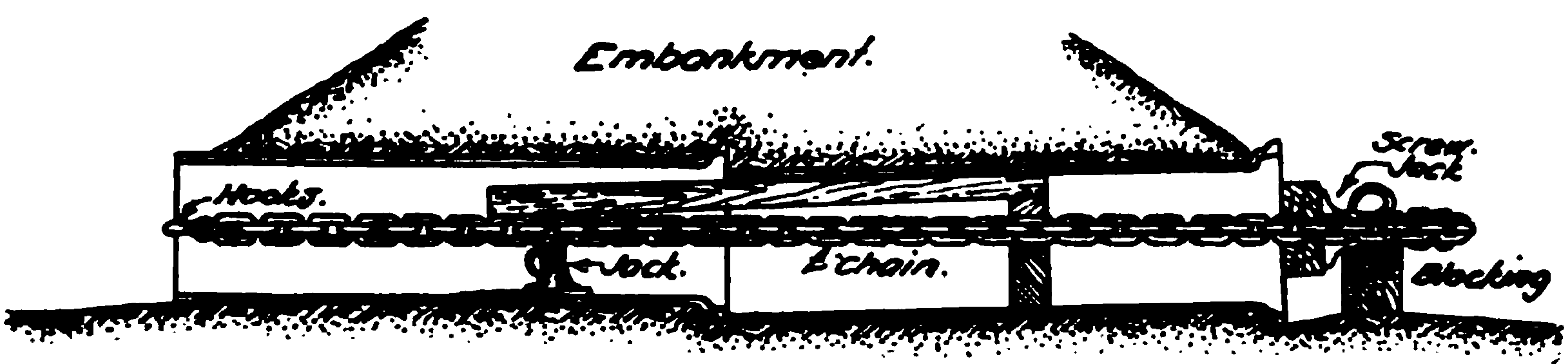
The only successful way of repairing pipe that is pulled apart under heavy banks is to dig them out and reset them. Under light banks, with open joints near the ends, I have jacked the ends up in line and pulled them together with crab and block and fall, either by anchoring the same at opposite ends of the pipe or by using jacks instead. Where the pipe has crushed under heavy banks I have lined them with one row of brick, laid rollerways, in cement mortar. Such was done where the pipe was sufficiently large to take care of the water after lining. In one case this was done under a 60-foot bank, and a 36-inch pipe flattened 3 inches out of true shape. This happened ten years ago and the pipe is still in good condition. In this case the pipe was broken under the center of the bank. At ends of the pipe, where it was undisturbed, no brick was placed. Where the brick terminated a sloping offset of cement mortar was put in to prevent drift, etc., from lodging against it. No trouble has been experienced in consequence of the installation of these brick.

In unloading and rolling iron pipe off cars where the ground is soft, the spigot end should be laid on the ground first, to prevent breaking. If the bell end strikes the ground first, almost invariably the spigot end will

either crack or break. On hard ground pipe should be snubbed off cars with a rope and skids, to prevent damage and breaking.

H. Rettinghouse, Division Engineer, C. & N. W. Ry.—I have always borne in mind the foundations for cast iron pipe were deserving of as much consideration as was required for other permanent structures, such as stone and concrete box culverts. I have never had a case of cast iron pipe pulling part except one instance during last summer where, owing to a slide of a high embankment, the end wall and last section of the pipe were crowded out. This, case, however, could hardly be considered as directly pertinent to this subject.

It is incumbent upon any one in charge of work to ascertain the character of foundations before placing important permanent work, and I have had in my experience a number of instances where I have driven a pile foundation with either timber or concrete grillage for the foundation of cast iron pipe in order to prevent settling of the same. In some instances where the subsoil was somewhat soft, but not considered soft enough to permit of a continuous settling, I have raised the center of the pipe line proportionately, so that when the settling of pipe has taken place the center will be on line with the ends of the pipe. This practice is one that should be followed for all ordinary cases, as it will bring the pipe joints to a snug fit after the pipe has settled to its final resting place. Proper judgment must in all cases be exercised. Although it is possible to set down a fixed rule as to the amount that pipe should be raised in the center, it is better that each case be judged on its own merits.



Method of Jacking Cast Iron Pipe into Place (Suggested by W. F. Meyers of C. & N. W. Ry.)

Lee Jutton, Inspector, C. & N. W. Ry.—In repairing an open joint in a cast iron pipe culvert when the distance from base of rail to the bottom of the culvert is five feet or less, the pipe should be dug out and relaid, at the same time providing a good foundation. When it is not advisable to do this, the joint can be repaired with concrete and cement. To do this the dirt should be taken out, as much as possible, under and around the pipe at the open joint and the space thus formed filled with concrete, finishing on the inside with cement mortar. If the waterway can be reduced at the culvert to be repaired, then a six foot length of pipe having no bell may be put inside to cover the open joint. The difference in diameter between the two pipes should be enough to allow two or three inches of concrete to be placed between them. At the up-stream end of the short length, the concrete should be tapered off, so that there will be no abrupt obstruction to the water.

W. F. Meyers, C. & N. W. Ry.—Cast iron pipe, when laid in soft ground, should have a concrete foundation the full length, which I think is the only way that pipe should be laid where the embankment is high. The amount of concrete to be used must, of course, be determined by the condition of the ground and the size of the pipe to be laid.

The sketch shows my idea of pulling pipe together without excavating, where the embankment is not too high and all that is required is to pull them back to place and hold them there. This can be done and they can be held in place by drilling a few holes in the bell and inserting bolts through

both pipes from inside. Of course, this can be done only where the pipe is large enough for a man to get inside to work.

When a cast iron pipe in a high embankment has pulled apart and can not be pulled into place by the above method I am in favor of relaying it by means of a tunnel, rather than by the use of false work and entire excavation.

The tunnel should be made large enough for a man to work in handily and leave room to put a small piece under each joint to hold the pipe up to place. Care must be taken in doing the back filling on a job of this kind, and the filling should be well tamped, to prevent the possibility of washing out at the side of the pipe in a loose fill. This is a good and cheap way to lay pipe where there is a high dump and where false work would have to be driven to dig it out. These tunnels can always be braced up with second-hand ties or other old material which is handy.

J. D. Moen, C. & N. W. Ry.—In my opinion, the manner of making repairs would be governed altogether by conditions. If the pipe be large enough for a man to work inside—say 36 inches—or over, and the aperture is not too great—it might be cleaned out properly and filled with cement concrete. In cases where the pipe has pulled apart and either end has not settled below the line of the other section, a steel jacket might be fitted tightly on the inside to prevent any leaking or wash. If repairs are made with concrete, as mentioned above, it, of course, would be difficult to fill the upper part of the aperture.

I have had good success filling crevices between cover stones, on stone boxes, by pressing the concrete into place. This was done by making a box of the same length and a little wider than the crevice to be filled, and deep enough to hold sufficient concrete for filling the opening. This box had a loose bottom made of 3-inch lumber and was filled with concrete and placed with the edges of the sides tight up to the under side of the stone. Two jacks were set under the loose bottom, and by raising the bottom the concrete was pressed into the crevice and allowed to set. Whether or not this method could be used in filling the upper part of the opening between the ends of cast iron pipe that had pulled apart, of course would depend on the size of the pipe and width of the opening.

R. J. Bruce, Mo. Pac. Ry.—I decide from the general condition of the soil, beforehand, what course to pursue. If the pipe was laid in firm clay, gravel or sand, the bearing power of such was considered as sufficient without additional support. If the soil was soft or unstable, timbers were laid crosswise in the trench. The sizes and number were determined by the character of the soil. Sometimes, where the soil was not too soft, second-hand bridge ties or short lengths of old bridge stringers were used, perhaps on 2 foot centers.

I had one case where it was necessary to drive a row of piling on either side of a 48 inch line, and put on short caps, upon which the pipe was laid. This gave very good satisfaction, but it is an expensive method. Of course, nearly all soil will settle at least a little, so that the pipe is bound to settle some. The amount of this settlement can be fairly well estimated and the pipe laid somewhat higher in the center by way of allowance. Any timbering or other support only sustains the pipe itself against settlement and has but little effect on the general settlement of the earth foundation.

Cast iron pipe should be protected at the ends with head walls. Care should be exercised in unloading the pipe from the cars and the earth should be tamped until the fill is level with the top of the pipe.

J. O. Potts, Mo. Pac. Ry.—For cast iron pipe laid in soft ground:—Use good old track stringers, such as 7 x 15 inches x 24 foot timber, laid longitudinally under the bottom of the pipe, breaking joints with the pipe and splicing the timber to each other with W. I. bars or wood. The dirt should be well tamped on each side of the pipe when the fill is made. The bell should be let down into the timber so that body of the pipe will have a uniform bearing. In some cases a concrete bed of sufficient depth and width is recommended, but we believe the timber bedding is equally as good and the cost will be only one-third as much as that of concrete.

F. O. Draper, Illinois Central R. R.—I attach two copies of blue prints showing our method of holding pipe in place in sliding fills, at the time it is placed; also showing a method of holding pipe in fills that are moving, where the pipe is gradually separated. You will note that we put side rods on the pipe, in place, at the time the pipe is laid. The inside rod is used on pipe that is not equipped with these rods on the outside, to hold the pipe from opening, as the fill settles.

I have had considerable experience in this class of work and I find that a rod of these dimensions is very satisfactory and will hold the pipe. The rod shown on the inside does not catch rubbish or driftwood during high water. It can be put in along the sides of the pipe and held in position by a small band supported from the bottom of the pipe.

J. M. Caldwell, C. I. & L. Ry.—I most generally lay a floor of old bridge stringers the full length of the pipe. The 16-foot stringers are cut in two in the middle and laid crosswise, making the floor 8 feet wide by the length of the pipe culvert. We have placed a great many pipes in this manner, in soft ground, and we have had but one or two cases where the pipe has pulled apart. The pipe I refer to is standard cast iron water pipe with hub and spigot ends. We never use galvanized pipe.

To repair the pipe when it has pulled apart, I use old boiler iron bent to the diameter of the pipe, placing two pieces, with flanges, at the top side of the pipe and bolting them together through the flanges.

We have discontinued using ordinary cast iron pipe and now have cast iron pipe in 3 feet lengths, with a lock joint. This lock joint prevents the pipe from pulling apart.

G. A. Manthey, M. St. P. & S. S. M. Ry.—I have installed a great deal of cast iron culvert pipe ranging in diameter from 24 inches to 60 inches, in fills from 5 feet to 30 feet deep. Some of this pipe was laid in very soft ground, but in every instance the muck was removed over a width of 12 to 14 feet, to a depth of 4 to 6 feet. After excavating I put in two courses of second-hand bridge timbers, the full length and breadth of the pit, securely drifting the timbers together with second-hand packing or drift bolts and then filled the pit to grade with gravel, tamping it to secure a solid bed. After the bed had been prepared in this way I would lay the pipe, calking the joints with tarred oakum and then put in the filling. For two years as inspector and seven years as general foreman of bridges and buildings on the Wisconsin Central R. R., now known as the Chicago division of the Minneapolis, St. Paul & Sault Sainte Marie R. R., I made a personal inspection of 277 culverts 24 to 60 inches in diameter and never found a single instance where the pipe had pulled apart.

J. E. Jewell, Southern Indiana Ry.—On the Southern Indiana Ry. we have an abundance of waste stone from the quarries, such as spalls and planer chips. We always bed the pipe in this material and have had no trouble. At two places we filled high bridges with frozen clay in winter and were bothered with slides which pulled the pipe apart.

E. J. Auge, C. M. & St. P. Ry.—We have, in very soft ground, put in timber lengthwise with the pipe. This, to some extent, has helped to keep the pipe together at the joints. I am of the opinion that cause of pipe pulling apart is due more to the action of the trains going over them than to the settling of the grade. In a large majority of cases where pipe was pulled apart I found that the pipe had not sagged or settled out of surface, but the joints were pulled apart from 1 to 4 inches. I think the lock-joint culvert pipe would prevent the joints from pulling apart in all cases except in a newly made fill that has not thoroughly settled. I have not been able to find anything that would stop culvert pipe from pulling apart in soft ground in a newly made embankment.

To replace pipe that has pulled apart, we sometimes are able to jack it back to place, but in the majority of cases we have to dig around the sections to get them back to place.

DISCUSSION.

C. A. Lichty.—I wish to call your attention to the fact that this subject refers considerably to lock-joint cast iron culvert pipe, and if there are those present who have had experience with it we should hear from them.

W. M. Clark.—We use a great deal of cast iron pipe, but we have never used lock-joint pipe. We generally buy a medium grade of pipe, except for that used through heavy embankments, for which service we get what we call "standard" pipe, it being of a little better grade than medium, to better stand the pressure.

My idea in putting in a pipe culvert is to lay the pipe so that it will not be necessary to pull it together; in other words, put it in so that it will not pull apart. I have laid culvert pipe on concrete foundation, on grillage, and by driving piles, and about in the same manner as is shown in the illustrations, and have had no trouble with it pulling apart. I did have one 60-inch pipe that pulled apart on account of the heavy fill settling, which pushed out the end walls, and that broke the pipe. By some freak it did not part at the first joint but nearly under the center. I repaired that by getting a piece of boiler iron made large enough to slip nicely in, and concreted around it. That was done four or five years ago, and while it is not on my division at the present time, I have not heard of any trouble with it since.

I think that the most economical way is to put in a foundation that, under ordinary circumstances, will not permit the pipe to pull apart, as I doubt very much if you will be able to pull them together with rods. I think that, in any case, one would have to dig them up and relay them. In pulling apart in soft ground there would be settlement enough so that it would be hardly possible to get the spigot to enter the bell if they could be pulled together. I now recall a circumstance where we thought the pipe had pulled apart, but you will find before I get through that the trouble was not due to that. We accepted a piece of work from the construction department, and about four or five months afterward we had a sewer stopped up. It was a 48-inch cast iron pipe. I went there and also sent the inspector there, and the division engineer went with me. We

looked it over and came to the conclusion that it had pulled apart and caved in. It was in a 28 ft. fill, and we drove piling and dug it up. When we got down to it we found it was short just about four feet of pipe, where the contractor had used boards and they had fallen in, so that it was not the fault of the pipe.

M. F. Cahill.—On the Seaboard Air Line we are using some lock-joint pipe, and so far we have not had any trouble with it. But while the lock joint is all right, I think the fewer joints we have the better results we will get. I think the best way to eliminate this trouble is to get a good foundation. Do this and you will have no pipe failures. We have never had any on our division, for we have always put in a good foundation. However, we sometimes recommend one thing and get another. I do not approve of the short joints of culvert pipe, I believe a 12 ft. length is the proper one, and when you put it in on a good foundation it will stay there.

G. W. Rear.—We use concrete pipe on the Southern Pacific. I would not be in favor of using iron pipe in a structure as that shown in the illustration of the Cleveland Short Line. The construction is too expensive, and the iron pipe is of no use there after the concrete is set. Where a foundation has to be put in I would be in favor of putting in a 2-ft., 3-ft. or 4-ft. arch. We use concrete pipe in 3-ft. lengths, up to 36 inches diameter. In openings larger than that we are using an arch reinforced with rods, and sometimes with rails. The reason for making the pipe in 3-ft. lengths is because it is easiest to handle, and we usually make it in a shop and ship it out, although if one is putting it in an opening that is very large it ought to be built in place regardless of the size of the pipe. We have some of the collapsible forms for this purpose. In putting these in, the ground should be carefully tamped, and if possible to fill at the time it should be carefully filled around the pipe. But as for cast iron pipe where the foundation is soft, it should not be used.

H. Rettinghouse.—This report seems to cover the question, but I think we are getting away from it. The question before us is: "What is the best method of pulling pipe together after it has pulled apart?" It has been indicated, but not proven by experience. A great many make suggestions as to how to do it, but nobody seems to have accomplished it. I agree with Mr. Clark, that it would be a great undertaking to force pipe together after it has pulled apart. In regard to the foundations,

I agree with Mr. Rear, where he refers to the method as used by the Cleveland Short Line. I would like to know what the pipe is in there for.

In regard to concrete pipe, we are at present making experiments, and have let a contract for 250 locations. The pipes are made in 8-ft. lengths and shipped out. Our present results have shown that 48-inch pipe can be manufactured and placed for one-half the cost of that of iron pipe, while with 36-inch pipe it is about two-thirds of the cost. I think that it will be successful. One of the greatest troubles that we have experienced is the uneven strength of cast iron pipe. I have made inquiry into the exact method of manufacture of cast iron pipe, but I have not been able to get any reply. The American pipe manufacturers have established a standard for cast iron pipe. They have something like eight classes of pipe. We have in the state of Iowa a great many instances where drainage pipes cross our tracks, and we make it a condition that under embankments the pipe must be cast iron, and it is beginning to be a question at each job as to the class of material we are getting. I was very careful to ascertain just what class of pipe is used for drainage purposes and I find that it is a second-class material. It would be a good subject to investigate and report on at a future meeting. I notice that one member reported a failure in a high embankment, which was probably due to this cause.

A. E. Killam.—I think that last year when the question was brought up it was asked under what conditions the pipe would draw apart. I was very careful to pay close attention to this on my inspections, to the concrete pipes we have put in, some of them 20, 30, 36, and 42 inches in diameter. They were all laid in 3-ft. sections. Of course the 42-inch pipe in three foot sections is very heavy, but it has been in three years, and in going over the road I could not find any case where the pipe had pulled apart. If there was any place that looked like soft material, where we put in a pipe, we first put in a drain to draw the water off. A concrete end wall was then built up to three or four feet above the pipe. Some of these concrete pipes are laid under 15, 20 and 25-ft. banks; we put in one under an 85-ft. bank. It was laid on hard bottom, and the pipes do not pull apart.

We have a great many iron pipes that were laid in the road when it was constructed, and some of them have been in

25 to 28 years; and in no case on some 200 miles, on the section where they are used, has a joint drawn apart a quarter of an inch, and the pipes remain clean inside.

It seems to me that the day is not far away when concrete pipe will be more generally used. I have been told that the Canadian Pacific Ry. has abandoned the use of cast iron pipe. I know Mr. Grady, of that road, and he told me that they had abandoned them for the reason they were not put in right. We have concrete pipes under 35-ft. banks, and we have them under 3-ft. banks; and, in any case the shallower the bank, the harder it is on the concrete, under the higher banks, 15 to 25-ft., the pressure is distributed, and in the low bank the jar of the locomotive is closer to the pipe. But if care is taken in putting in the foundation and the pipe, as is generally done with us, we believe concrete pipe the cheapest and the best. We used to secure cast iron water pipe that was defective, but good enough for culvert pipes, but now the concrete is being used pretty much altogether.

Mr. Rear.—What has been your experience with concrete pipe in frosty country? Does the water running through the pipe and then when freezing, break the pipe? We have no locations where it would freeze.

Mr. Killam.—On a number of the lines where we have been using concrete pipe the temperature goes down to 35 and 40 deg. below zero, and still the pipes are all right. In the Provinces of Quebec and New Brunswick, it does not get below 15 below zero, but in no case has the frost affected the pipes. We do not allow pipes to be put in that have been made less than one year. They must get thoroughly seasoned and as hard as possible before placing them in the ground.

Mr. Penwell.—I suggested this subject to the committee last year, because we are spending a great deal of money each year rejoining iron pipes. In order to get at the question intelligently, I might state that we have a road (Lake Erie & Western R. R.) extending through the states of Illinois, Indiana and Ohio. Iron pipe was used years ago and we are still using it as a matter of economy. We use from 12-inch up to 48-inch diameter pipe. At first we built stone end walls for all sizes; at present we build them only for the 48-inch size; for the smaller sizes it is more economical to project the pipe than to build the masonry. It has been our experience that many of

the joints separate and the only method we have found to repair them is to dig them up, place them together and refill. I have tried to devise some means of drawing them together in the fill but have been unsuccessful. We have some which have pulled apart where the foundation is of solid clay, and the pipes lie in a line as straight as when they were placed. I can not account for it unless it may result from the thrust and jar of the trains together with the action of the frost behind the end walls. I find also that they pull apart more readily in mucky ground.

I might state what little experience we have had in preventing iron pipe from pulling apart. Recently, when placing some pipe we calked the joints with a cheap grade of oakum and filled the joints with cement. In doing this some feared that we made the joints too rigid and that the pipe might break in the case of settling. We use 12-ft. lengths except when it becomes necessary to use 6-ft. lengths to fit the embankment, but in no case less than 6-ft. If the cemented joints prove satisfactory in holding the pipe together we have solved the second part of the question to our satisfaction, but we are still "at sea" so far as rejoining, without excavating, those which have pulled apart. I do not like to spend the money necessary to make the excavation for repairs. If we find joints parting I make a record of it and check them again the following year to ascertain how much they are opening up each year. We begin this record when they show a movement of 2 inches. I am anxious to find if others are successful in rejoining pipes, when pulled apart, without the necessity of excavating.

I do not approve of putting in a foundation of old timbers for it is likely to rot near the ends which would cause trouble. If one uses concrete for bedding the joints it increases the cost; it might be well to bring it up to one-fourth the height of the pipe on the outside in mucky ground. We want to continue the use of iron pipe because it is economical.

I am not in favor of the lock-joint pipe; I think it would not prove satisfactory where the ground is soft, because the 4-ft. joints would become uneven and break the locks. I would not favor it except where it is incased in concrete.

Mr. Lichty.—I wish to call Mr. Penwell's attention to the fact that the lock-joint pipe is made sufficiently large in the joints to permit of a sag of 3 to 4 ft. in a culvert of 48 ft. in

length. They do not lock up perfectly rigid. It has been the experience of nearly all who have used the lock-joint culvert pipe that it has given satisfaction. Several of our members express their approval of this kind of pipe in this report, and I believe that none condemn it.

There is no question in my mind but that the action of frost behind head walls pushes them outward to some extent, and if the pipes are firmly joined to them they must of necessity tend to separate at the joints. It is self-evident that it is the outward thrust of the embankments at the bottom, resulting from frost or the weight of the trains that causes pipes to separate at the joints.

Mr. Killam.—I think I am safe in saying that on our road there is not an end wall that has been affected by frost. Some of them have been in seven or eight years, and there is not a defective one on the entire road, and they are practically as good as the day they were put in. In some places the frost will disturb them, but in soil such as we have there is very little of this. The soil is clay, mixed with sand, a kind of a loam soil, and the consequence is that it is seldom that we have found defective pipe and end walls where they have been put in properly.

Mr. Jutton.—We have been talking a good deal about the foundation under cast iron pipes. I think it is quite important to have the earth around the sides and the top of the pipe uniformly and firmly packed. Especially should this be done where the distance from the base of the rail to the top of the pipe is only two or three feet. I have seen iron pipes unduly stressed by engine loads, because of the load being concentrated on the top of the pipe and the pipe not being properly supported on the sides by the earth. Under such conditions I have seen the pipe spring down as each train wheel passed over.

As to the settlement of cast iron pipe, this is not a serious matter if it doesn't go too far. Suppose there is a little settlement, the water will go through and no harm is done if the joints do not pull apart. Mr. Rettinghouse in his letter speaks of placing a crown in the line of pipe when it is laid, with the idea that the culvert will be level when all settling has ceased. This appears to me to be a good idea, but the curve should be laid so that no point on it is higher than the point at the end of the culvert on the up-stream side. In other words, no part

of the culvert should be on an up grade, because in case there is no settlement, the culvert will always have a high point to which the water must rise before it can flow through. On the other hand, if the culvert is laid with the high point of the curve at the up-stream end, there will be a fall at every point of the culvert, even if it does not settle.

J. M. Staten.—We filled a trestle 48 feet high, and we had filled it up ten feet before we decided to put in a drain. The work was done with a steam shovel and plow, and when we decided to put in the pipe we took ten inch pipe, and we put in three rods and laid it on that soft fill. That was eighteen years ago. I have seen that pipe and it is still carrying the water just as well as when it was first put in.

A. A. Wolf.—Ninety-eight per cent of our culverts are built of wood. To use anything else would involve such expense that we could not consider it. Of course it is a good matter to provide foundations. We provide extra pipe, instead of end walls. I have had pipe that separated regularly so that we had to relay it in three year periods. I attributed this to the yielding condition of the soil. Every train that ran over it would help it to settle, and the soil would gradually work in and get into the joint, until it finally sprung apart. I do not think it is practicable to get sufficient force to move the pipe to rejoin it without uncovering. I think the cost would be prohibitive, and for that reason the only way we can rejoin the pipe is to dig it out and relay.

Mr. Penwell.—I like Mr. Rettinghouse's idea of crowning the pipe. We do that, and, of course the amount of it is governed by the condition of the ground. Some require a little, while others require a great deal, but we crown it just enough so that it will go down to a straight line, when the grade is finally settled. We have one pipe under a 60-ft. fill and it is 144 ft. long; we have not had a particle of trouble with it. In pulling these together, I have thought of devising some means of using heavier rods, and hydraulic jacks, and if others have tried it I would like to hear from them. It has been suggested that we use turnbuckles, but in a small pipe it would be impossible to get inside to turn them, and so I think we would have to resort to hydraulic jacks.

J. H. Markley.—We had a 4-ft. pipe which began to show signs of trouble but, by following it up with close inspection,

we got at it before it gave us any trouble. We put four two-inch rods through and heavy timbers across the ends of the pipe. We then prepared a ram, and, with the aid of jacks, we succeeded in putting it together. Now this pipe was in four sections, almost ready to drop out of the joints.

Speaking of putting pipe on foundations, I experienced some trouble. We had three sections, 12-ft. each, which we laid on a bed of stringers, 30-ft. long; on my last inspection, about four months ago, I found the joints had pulled apart two inches. I thought when I had that foundation down I had a "sure thing." What makes this pipe pull apart, I have never been able to solve. Speaking of omitting end walls to save expense, I have tried that, to my sorrow. We omitted putting in the end walls in some cases and the water came up and washed out the embankment. On that account we now put in end walls regularly, to avoid such trouble as this.

W. M. Clark.—I would like to ask Mr. Rear about the manufacture of the concrete pipe. What reinforcement do you put in? and do you use any water-proofing composition?

Mr. Rear.—In answer to Mr. Clark, the general practice with us is not to reinforce at all, up to three feet, and we do not make anything larger than three feet, unless it is special. We make 12-inch, 18-inch, 24-inch, 30-inch, and 36-inch, with the walls six inches thick. We also make 12-inch pipe with the six-inch wall. We use this where we have to put it in close to the rail. We use no reinforcing, except in special places. We do not use any waterproofing either. We let the pipe stand about thirty days, or as much longer as we can, before putting it in.

Mr. Clark.—How do you fasten the joints?

Mr. Rear.—They are made as a sort of an imitation bell and spigot, and they are just joined together, and I might say that we have had some of them pull apart. If they pull apart we get inside and cement them again and we try to keep it cemented as fast as it stretches.

Mr. Ashby.—Pipes ought not to pull apart. Neither ought trains to come together, but they do. As far as using a reinforced concrete pipe, I have not had any experience, presumably because I am close to the source of cast iron, and we use a great deal of that.

J. W. Fletcher.—I have not had very much experience with cast iron pipe, but we took out a trestle and put in a 20 foot fill,

and I would like to show our method of putting in the pipe. We took the old trestle chords and laid them on each side and then took the ties and laid them down so that we had a solid foundation. That has been in seven years, and we have never had any trouble, and it is in perfect condition.

A. H. King.—We put in a great deal of pipe, in fact it has been the standard construction for many years; it is from four feet diameter down, and I agree with Mr. Cahill that we want as few joints as possible. My idea is that as we multiply the joints we multiply trouble. I do not see why joints should pull apart; but the subject is what is the best plan of pulling them together, and I think that when pipe pulls apart it is entirely due to having been improperly laid. We get along very nicely with 12 foot lengths, and we use it in all our work, putting it on a timber bed. This has been my experience, and we have never had any trouble with cast iron pipe when properly laid.

Mr. Jutton.—I would like to call attention to the letter from Mr. Stuart of the Erie, on this subject. He states that it is better to tie the head walls together than it is to put clamps on at each joint in the pipe. Thus if the end lengths of the pipes are held rigidly in the head walls, and the head walls are anchored together the line of pipe is free to move laterally and vertically, but cannot move endwise.

Mr. Staten.—For culvert pipe, we are using some of the corrugated iron pipe which is made in Richmond, Va. They are using considerable of it around Richmond in the making of good roads, and they can make them in any size. We are using some of it in 18 and 20-inch sizes. They ship them out in every length, and the section men put them in. We have not had time enough to find out whether they are going to be serviceable.

Mr. Clark.—In answer to Mr. Staten, I would say that about 12 years ago somebody got out a patent on a wrought iron pipe. It was not corrugated, but made in big sheets and riveted together. At that time I was with the Pittsburg & Western Ry. and we used a number of them. We had occasion four or five years ago to take a number of them out, some few of which we found in fair shape, more of them we found practically useless and none of them in shape to use again; so that experience leads me to believe that a wrought iron pipe of any dimension is bound to be short-lived, although I know of one 36-inch pipe in a 40 foot fill that is still being used and is

doing business. Inside it looks all right, but I don't know what it is like on the other side. It would not surprise me if some day it would collapse and this is the point I wish to bring out. Probably Mr. Staten will find the same trouble. This one is in a fill that was made 12 years ago. I would not recommend wrought iron pipe for heavy work.

Mr. Cahill.—In the mater of corrugated pipe, the Seaboard is using some of it, from 12 to 24 inches in diameter, I think very little of it, down in our region where all metal and timber are subjected to the severe atmospheric conditions; but in addition to that I do not think they should be used from an economical standpoint. The corrugations in the pipe are in the wrong direction. They are crosswise, instead of lengthwise, and do not facilitate the passage of water. Each of those corrugations will hold sand and sediment and it will be only a short time when the water, of the quality that passes through will eat off the galvanization on the pipe and after that it will be short lived. We have not used it long enough to know what the results will be, it is only a temporary substitute at best. But then we can recommend one thing and they send us another. Sometimes they learn the lesson too late. I say again, it is a poor substitute for cast iron pipe.

J. M. Bibb—In regard to the cast iron pipe, I had a little experience in a 20-ft. fill. The bank by slipping pulled the joints apart, about eight inches. We did not pull them together, but we took forms and concreted solidly all around them at the joints which settled the difficulty.

Subject No. 4.

BUILDINGS AND PLATFORMS FOR SMALL TOWNS.

REPORT OF COMMITTEE.

The subject assigned the committee was "The Standard Arrangement of Buildings and Platforms for Small Towns, as to Convenience and Appearance."

The term "small town" is rather indefinite, but it is taken by the committee to mean country towns with a population of perhaps a thousand people or less. For such places the subject may be divided into two classes:

First. where but a small amount of freight is handled; and, second, where quite a large surrounding country receives or delivers its freight shipments in large quantities. There is also a third class, such as applies to summer or other resorts and suburban towns, which, of themselves, are small, but have a large volume of passenger traffic at more or less irregular periods. Of the latter, each case must be considered separately and no standard could be laid down.

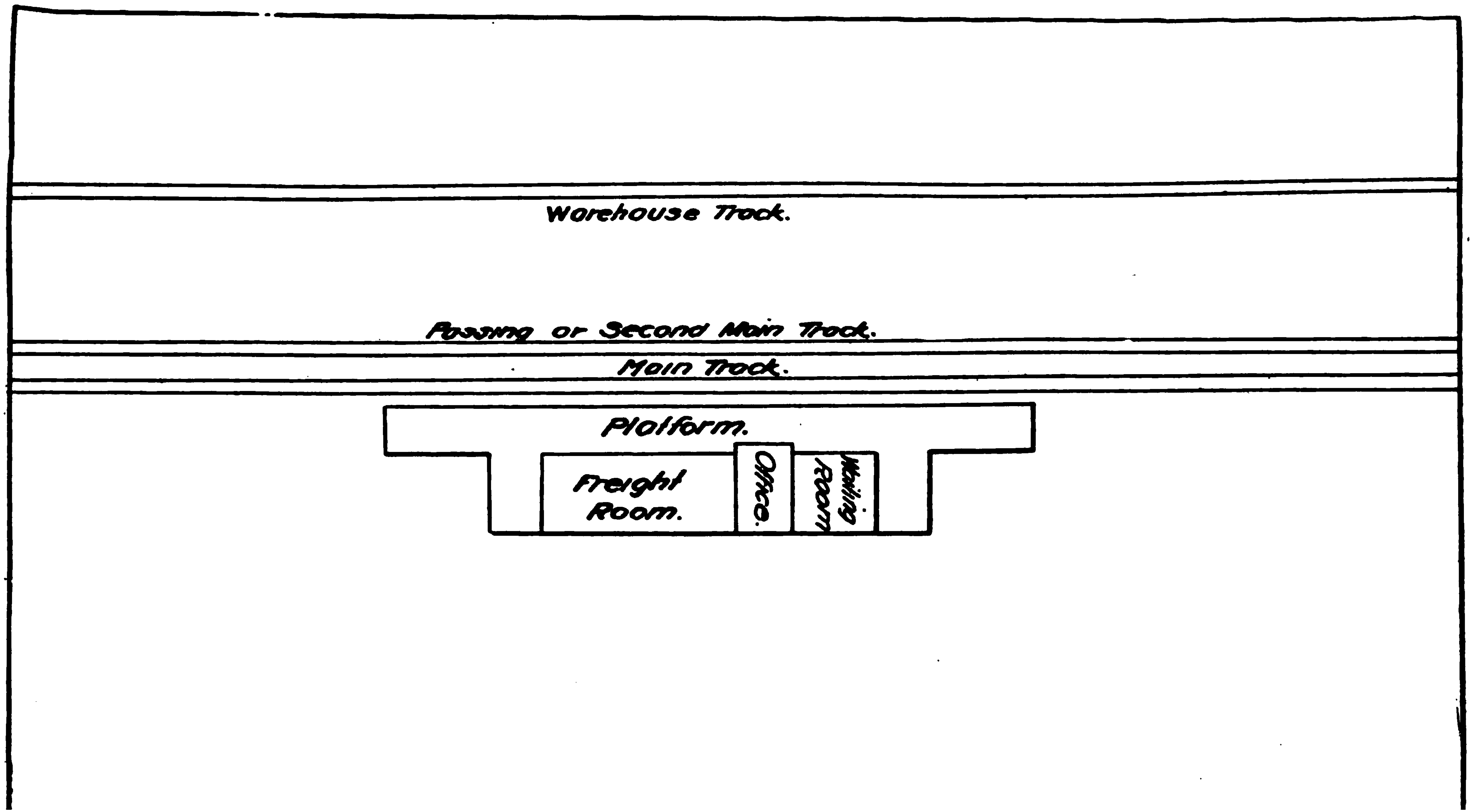
Considering, then, the first class, where but a small amount of freight or passengers is handled, it would seem that a combination freight and passenger station should be used. The platform should be less than a foot above the rail and not less than 10 nor more than 16 feet wide. The length should be governed by the maximum length of train scheduled to stop at that town. A small platform on level with a car floor may be desirable, inside, or at the end of the freight room, but should not be near enough the track to endanger passengers or employés.

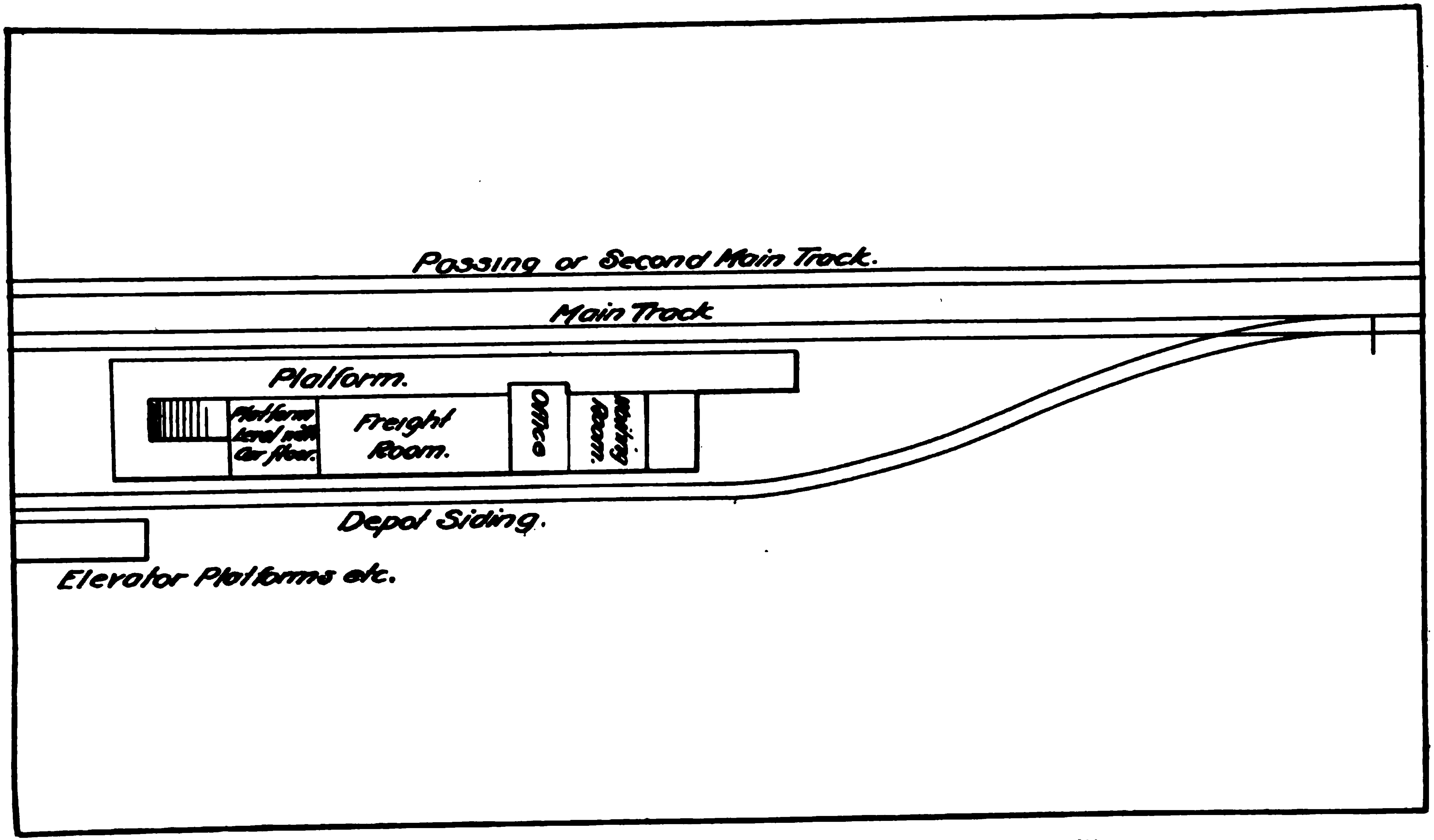
The station should, wherever practicable, be placed on the side of the track nearest the town. When, as is usually the case, the station is located near a street that crosses the track it should, if practicable, be located so far from such street that the local passenger trains scheduled to stop there do not obstruct the street. At stations where such street or highway exists, the waiting-room end of the station should be toward the street or road and the freight room at the far end. This will overcome, in a large measure, the danger of passengers walking or stumbling over freight left lying on the platform at or near the freight room.

For stations where but a small amount of freight is handled, a house track back of the station is not desirable. Where, however, a large amount of freight is received, as is occasionally the case in small towns and on busy roads, and considerable time would be lost by local freight trains getting out of the way of other trains, a track back of the station is desirable. With such an arrangement merchandise freight received in large quantities may be unloaded by the station or other forces into the freight rooms, and local freight train crews may be unloading while waiting for through trains to pass.

Elevators, coal bins, cotton and broom corn platforms, stock pens and such structures may then advantageously be located along the side track, but far enough from the station or other important buildings as not to endanger them should they take fire.

Ordinarily, section hand car and tool house should be placed next to the main track and outside the side-track limits. Much time is frequently lost


Warehouse Track.
Passing or Second Main Track.
Main Track.
Platform.
Freight Room.
Office.
Waiting Room



General Plan of Station for Small Towns, Recommended by the Committee.

by section workmen being prevented from leaving their tool houses by trains standing on the main or side track within the side-track limits.

Coal bins, coal boxes, privies or other out-buildings must be located to suit the general conditions of the town, climate and surroundings. In northern climates it is probably best to store the coal in a bin partitioned off in the freight room. If this is not practicable, an outside building or covered box may be used. A coal house adapted to the needs of a station in Dakota would be out of place in Florida.

The arrangements herein recommended are intended to cover usual conditions existing in small country towns along single and double-track roads. Where roads have three or four main tracks, conditions are entirely changed and the suggested layout is not applicable. On such roads, each station presents its own problems and must be considered individually and as a study of itself. The committee therefore makes no recommendations for the arrangement of station buildings on such roads.

With the foregoing recommendation we submit drawings of proposed arrangements of buildings and tracks.

As for station and platform design on European roads where the population is dense and where conditions may be, similar to those which obtain at small towns in congested districts in some parts of our own country, the files of the Bulletin of the International Railway Congress contain numerous papers and reports of studies that have been made.

C. H. FAKE, *Chairman.*
N. H. LAFOUNTAIN,
R. C. YOUNG,
A. W. MERRICK,
J. S. BERRY,
F. D. BEAL.

DISCUSSION.

R. C. Young.—Mr. Fake took charge of the preparation of this report. Of course we all submitted our ideas, and the recommendations are not in accord, in several particulars, with the ideas of some of the members. Substantially, however, I think the report covers the conditions in most small stations on single-track railroads, the idea being to economize track room, and station help. Referring to the sketches attached, you will see that the elevator or warehouse track is so arranged that it can be used for a team track. It is usually the case where quite a large trackage is necessary, but where it is not used all the time. This can be used for team track purposes without interfering with the needs of the warehouse. Personally, I see no objection to having a small platform close to the station. The other members of the committee overruled me and submitted it as you see it. I have had such platforms, keeping them far enough away from the track. I have found that by putting a skid across from the car to the platform the agent is saved considerable

work, and it makes it easier for teams when they come after freight.

Mr. Mills—I move that the report be accepted.

President.—We would like to hear some discussion on this subject.

Mr. Penwell.—I would like to second the motion made by Mr. Mills.

President.—The subject is open for discussion.

Mr. Penwell.—There is one thing I don't like like about this, and that is the track back of the freight house. I don't see how they are going to get freight out. I presume it is the intention to put a car on the back side of the depot, and let it stand there. I don't like the elevated platform, for there is some danger in it, and I think if we could get rid of that track it would be all right. If we should recommend that for adoption to our general managers, or to the operating department, the first thing the superintendent would inquire about is how are you going to get the freight out of the house. The plan might be modified and changed in order to cover that requirement.

Mr. Young.—In regard to this plan No. 2, I objected to it myself, and I finally consented to its adoption, because by the use of it for unloading and loading freight it will avoid the blocking of the main line. I think if it is adopted, it should have a platform on the back side of the depot, and the elevated platform extended so that the freight can be trucked to the end and delivered to teams. I do not think there are very many cases where such a design would be desirable. It is a second design made to cover cases where the first did not seem to fit.

Mr. Killam.—This plan, with the track back of the station is such as was adopted by the various roads in Canada, some thirty or forty years ago, but of late years they have been done away with, on account of the danger in crossing. In all cases the track is now built in front of the station and not at the back, on account of the danger to the public when they are in a hurry in getting to the trains, and crossing this track. The high platform is being done away with on account of people falling off and getting hurt. All of the new stations are now made so that the platform is about 12 inches above the rail, and the back track is being taken out. I fear that if this plan is adopted with the track at the back of the station, we will be ridiculed, because the front part of the station is where the

business should be done. In all cases we have 18 ft. 6 in. between the rail, and the front of the freight house. At each freight house, no matter how small the station, it is equipped to take care of heavy freight, and there is a plank that can be moved for use in handling heavy shipments. In this plan, the way the back of the station is arranged, there is a danger to the public; at least it has been considered so with us, and our railroad is under governmental control.

Mr. Rear.—I am sorry that the Southern Pacific did not have an opportunity to have something to say in connection with making up this report. We have had it up for thirty or forty years, and it is one of the things that is difficult to settle on our single-track lines. On the western lines we unload all our small shipments by the way-freight crews, and the agent does not unload any freight. We have a team track in front of the station where carload shipments can be unloaded out of the cars, but small lots have to be unloaded out of the cars, and sometimes out of five or six cars, and you cannot unload it off the main lines. Where, then, will you unload it? For years we put in a track between the platform and the depot which was used for unloading freight into the freight shed, and it was unloaded by the way-freight crews; and when a local passenger train came through, they had to get out of the way to allow the passengers access to the train without being interfered with by the way-freight crew. Here we adopt a plan of putting the track on the back side, which is used only for unloading the cars by the freight crew, and probably for only 15, 20 or 25 minutes per day; and, as soon as they have finished, the track is available as a team track and on that side of the depot we have a platform; so it seems to me that this subject ought to be carried over and see if we cannot get some plan that will overcome our objections to a back track. There are certainly objections to an unloading track being in front of the station, and as I am a member of the subject committee for next year, I am going to see if we cannot have it continued.

Mr. Killam.—I might say that for some of our important stations there is a spur track at the further end of the freight house, where they unload full-loaded cars, where they can unload 7, 8 or 10 cars that never go into the freight house, the goods being unloaded directly from the cars. But the way-freight unloads in front of the station, and when a passenger

train comes in, it, of course, runs ahead and takes the siding. I speak more with reference to the side-track which has been condemned by us. It is the tracks at the back of the station which have been abandoned by us. The spurs have been used for unloading partial or whole loads.

Mr. Penwell.—It is casting no reflection on the committee to criticise. The little platform at the end of the depot is useless, and is a storage place for trucks, old banana boxes, etc., and as appearance is taken into account in connection with this subject, we have to look out for it; I cannot consistently recommend that the platform be put in. I think we have got to dispense with that track back of the station before the general managers of our railroads will approve it. Neither do I like the unsightly platform at the end of the freight house. If a town is not important enough to have a separate freight house, it seems to me that we will have to stick to the old policy of unloading from the main track to the house. You have got the freight man to contend with, the division superintendent, the general superintendent, and the general manager, and I think the subject is worthy of another year's study, and the same committee can get some more information from the various railroads. We must also consider whether or not we are going to place an extra switch in our main track. We know that all progressive railroad men are getting as many switches out as possible, and in this plan we have got to consider that question.

Mr. Clark.—I have listened to the discussion with some little interest and it appears to me that it has resolved itself into about this: that local conditions will govern the necessity of platforms. I do not think that this or any other association can adopt any standard or any idea respecting platforms suitable for all stations, and I don't think it would be wise for us to try it. I think that all the roads are something like the one I am connected with. When it is necessary for a platform to go in, we generally get the superintendent to say what he wants, and then we put in the platform accordingly. We know very well that conditions sometimes are such that a platform of 20 feet will accommodate any business at these small stations, but at certain times business may improve at that station, so that our platform is totally inadequate and some other arrangement will have to be made; or it might be the reverse, and I cannot see that any resolution that we adopt here will do

us any good in view of the facts as stated; that it is a question which local conditions will govern, and a platform for one station may not answer for another.

Mr. Cahill.—Every one knows that different localities require different conditions. The little village that our president lives in has to have a platform that covers a half acre of ground, and that will take care of from ten to fifteen thousand bales of cotton. It is very frequent that we handle from one to four thousand bales of cotton at a very small station, so the question of locality, conditions, and requirements must take care of itself.

Mr. Staten.—Our standard on the Chesapeake & Ohio Ry. for platforms is six feet wide in front of the freight house and eight feet at the back. The freight trains unload there, and if there is anything that cannot be handled we have a plank that two men can handle, about 8 or 9 feet, and they roll the heavy stuff out and lay it alongside the platform. The floor of the freight house is about on a level with that of the car and we do not have very much trouble with the freight we handle.

Mr. Perry.—I do not know much about platforms. We have varying conditions at stations, and we have to make platforms to accommodate these places; and I do not see how we can get out a design for a platform to fit all conditions. On our road we have cases where it requires a great deal more platform space than at others, and we have to know that before we can design them. I believe as Mr. Clark says that we cannot make a standard design to fit all cases.

Mr. Young.—I make no objection to having this question referred back to the committee, as I think there are some objections that ought to be thoroughly investigated. I do not think it is possible to design a platform to meet every case. It is necessary in my territory to build some platforms a great deal larger than others, and we have to locate and study them before we can design them. As to Mr. Killam's objection to the height of the platform, let me say that this platform is for carrying freight out of the car, and it is a platform that passengers have nothing to do with. It is merely a platform for the freight house. I think the question has not had the proper consideration, and I am personally in favor of having it continued by this committee, or by some other committee, until next year.

Mr. Rettinghouse.—I believe it would be unwise to adopt this plan as standard, and I move that the report be carried over to another year.

Motion duly seconded and carried.

The motion to accept the report was withdrawn by Mr. Mills.

SUBJECT No. 6.

SUPERELEVATION ON BRIDGES.

REPORT OF COMMITTEE.

Superelevation of the outer rail for curves on bridges may be obtained by one of the following general schemes, or a combination of two or more of them:

1. By building the masonry bridge seats out of level or by using beveled shoes of different heights under the bridge bearings, as in Fig. 1.

2. By building the stringers or girders supporting the ties so that their tops will be out of level (Fig. 2).

3. By capping the trestle bents, either pile or frame, out of level or the equivalent of using a tapered cap, a tapered shim on a level cap or by tilting a framed bent on inclined footings (Fig. 3).

4. By tapering the ties, as in Fig. 4.

5. By shimming under the ties, as in Fig. 5.

6. By shimming under the high rail, as in Fig. 6.

Thirty replies were received to a large number of circulars sent out by the committee and the first five of the methods above received approximately equal numbers of advocates. No. 6 has no supporters.

Ballasted-floor bridges are not here specifically considered. They solve the question of superelevation at once, without special consideration; although for bridges of this class on curves some provision should be made to prevent trackmen or the action of trains from throwing the rails from their exact prescribed position, else there may be trouble from improper clearance.

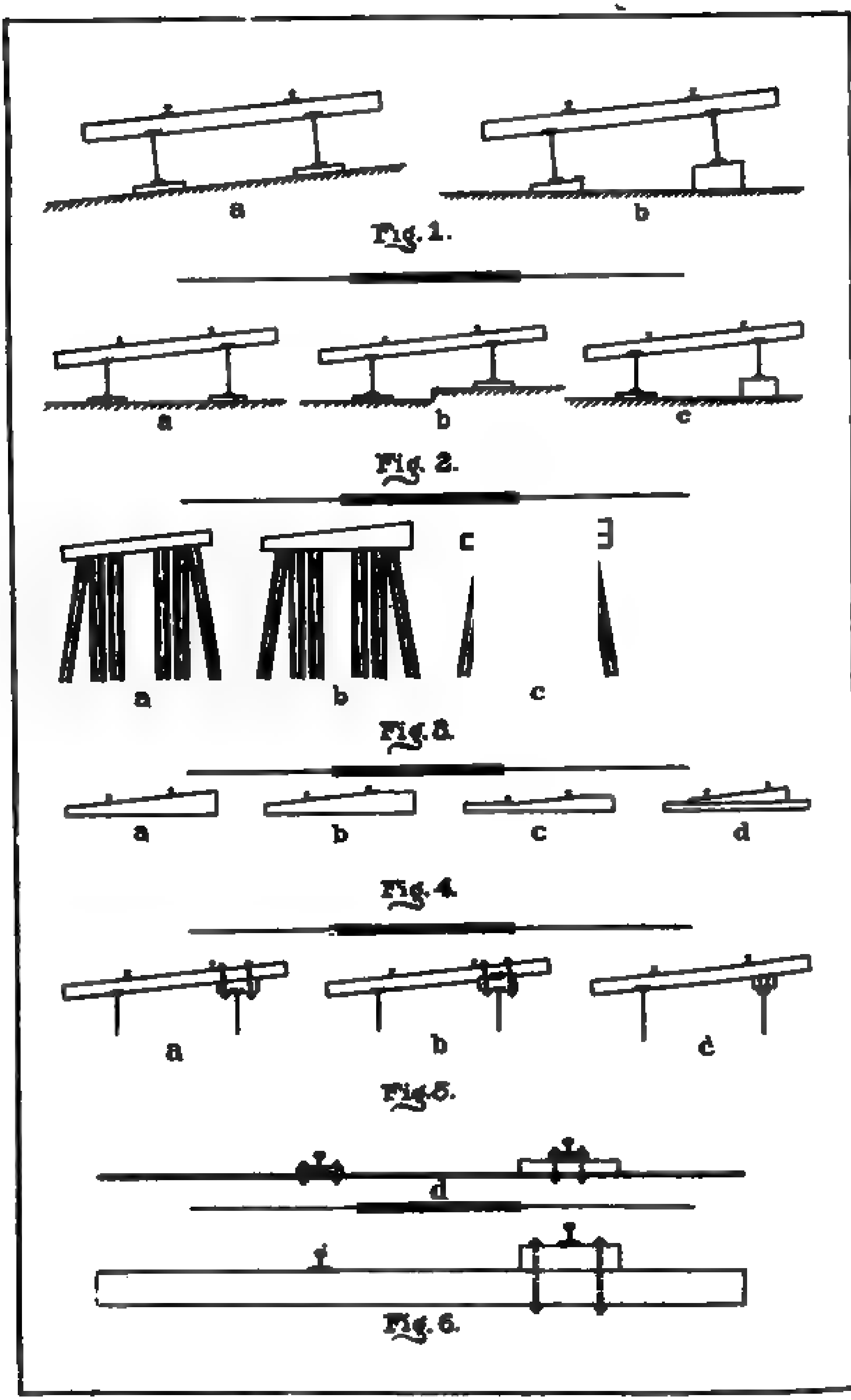
1. In Fig. 1 the girders are inclined from the vertical. For moderate elevation it is advocated by twelve replies. Some doubt the advisability of this inclination, on account of the action of the live load; but one thoroughly competent engineer considers that the girders in this position support the loads more conformably to the calculations. It is likely that high speed trains will strain the transverse bracing less, and slow trains more, than if the girders were vertical.

Several object to Sketch "a," on account of the difficulty of building the masonry. If of concrete, however, such difficulty is not apparent. Many advocate securing part of the elevation in this way and the balance in the ties.

Several replies class this scheme as bad practice. It is of course out of the question for truss spans.

2. Thirteen replies favor the scheme in Fig. 2. A few object to it on account of dapping the ties across the grain. Cases are numerous where ties have split when so dapped, necessitating bolts. The scheme is applicable to deck and through girders as well as to truss bridges.

3. The method shown in Fig. 3 applies only to timber trestles, either pile or frame. Fifteen approve one style or other of this figure. A few object to "a" as difficult framing or as being unsightly. Plans "b" and



Various Methods of Obtaining Superelevation on Bridges.

"c" require an excess of timber, and "c" furnishes a bad joint for inducing decay.

Plan "d" is advocated by only one reply. The purpose of this style seems to be to secure square framing.

The committee is not a unit on this matter, but those having the largest number of trestle bridges prefer Style "a," and experience no difficulty in its use.

4. Seventeen expressed approval of some style of tapered tie (Fig. 4). All should have a certain minimum depth under the low rail equal to the standard for the stringer spacing in use.

Several members object to tapered ties of any kind, holding that the regular stock size for straight-line bridges should be used in all cases to simplify labor and material carried for repairs.

Style "b" allows the use of a smaller stick than "a" for a high elevation and is just as efficient.

Style "c" is the standard on the Boston & Maine road for metal bridges. It is somewhat expensive, in that it has to be adzed to shape; but bridges on curves are of no great length and the labor item for a given bridge is hardly appreciable. Its advantage is that the depth at the thin end is not reduced too much for properly holding the guard timber, and that the low rail is not canted away from the traffic, as it is on all other inclined ties.

Style "d" is advocated by one reply as a good method on a double-track deck with long ties. The shim is 8 feet long and is well bolted to the tie.

5. Nine advocate shims under the ties. Several object to these on account of their getting out of place, etc. Style "b," used by the Baltimore & Ohio R. R., when 16-inch timber in style "a" Fig. 4, does not give sufficient elevation, can hardly be subject to this objection.

Style "c" is advocated by some and objected to by others. It is a longitudinal timber as wide as the girder flange and bolted thereto.

Style "d" is used on solid plate-floor bridges without ties. It is objectionable on block signal lines, as perfect insulation is uncertain, which necessitates cutting the bridge out of the circuit, so that a car on the bridge or a broken rail on it would not put the signal at danger.

The scheme as portrayed in Fig. 6 received no support among the replies, except for temporary work.

All the schemes shown except No. 3 apply to metal bridges. It is well agreed that timber bridges of all kinds should have the stringers placed in a plane parallel to that of the rails. In the case of trestles, it is the opinion of the committee that there is no valid objection against framing the caps to the proper inclination to receive the regular standard straight-line tie. In timber stringer bridges resting on masonry, tapered wall plates should be used.

For metal bridges any of the schemes described will give good service if the fitting of the ties to the bridge and of the bridge to the masonry is perfect, so that no movement will occur. The simpler these fittings are, the more certain it will be that good fits will follow. To secure favorable conditions of simplicity the masonry should be level and the lower face of tie should be parallel to the plane of the top flanges of the stringers. These conditions reduce us to "b" of Fig. 1 or to Fig. 4. Our replies indicate that not over 4 in. superelevation should be obtained by scheme 1; hence if more is required it should be obtained wholly by 4 or by a combination of 1 and 4.

J. P. Snow, *Chairman*
W. F. Steffens,
D. G. Musser,
M. Burpee,
F. L. Burrell,
W. M. Clark,
Committee.

DISCUSSION.

G. W. Rear.—I move that it be the sense of this association that from a practical bridge man's standpoint, Style a, Fig. 3, is the only practical method of framing pile bridges, and that Style c, Fig. 4, is the only practical method of putting superelevation on ties on metal bridges.

F. E. Schall.—It seems to me that we are not in a position to vote on the acceptance of the methods of obtaining superelevation without discussion. We are not ready to vote yet.

Mr. Rear.—I believe that we ought to show what the recommendation of the bridge and building men is in our report. It seems to me that in an association as large as this, of men who are doing the work, they should agree that some things are the best. I want to say that those two methods of framing trestles and putting superelevation on steel bridges have been adopted by the Harriman lines, after a long discussion by the chief engineers and the bridge men of those roads, in convention by themselves.

The deck is the cheapest part of a steel bridge; a good riding track must be maintained, and it is the easiest place to maintain it at the smallest cost. I believe in the practice of making reports and showing what we are doing.

Mr. Jutton.—I think that it is a good idea to adopt conclusions in our reports, but first we should have a discussion which will show why we decide on the given conclusions.

Mr. Gumphrey.—If you will excuse me, this being my first meeting (and I understand that in the senate they do not allow a new member to speak the first year), this is a question on the superelevation of track on bridges. Some of the best engineers in the country have not been able to settle the question satisfactorily, and I think this convention is taking hold of a pretty hard proposition. I wish to take issue with the gentleman from the Southern Pacific as to his plan for ties on metal bridges, and I would like to know how he will get the elevation for a 16-degree curve by his method.

Mr. Rear.—We have bridges on 16-degree curves, but use only six inches superelevation on any curve. We use an 8x16-in. tie, and by our method we saw one end and batter it across Six inches is our maximum cut and on all bridges our standard

tie can be used. An 8x16 tie will afford the necessary cutting for six inches of superelevation. These ties are sawed in our mill, and we order so many ties with so much elevation. It seems to me that while it is not the cheapest and easiest way to put the elevation in, it is the best.

Mr. Gumphrey.—Our maximum superelevation is 6½ inches. In one place where our trains are run 45 miles an hour the question came up about superelevation. I ordered ties beveled from 8x16 to 8x8, and the bridge engineer took issue with me, but after considering the matter awhile he made up his mind and he said that we would order the ties with part of the elevation in the bevel, and put the balance in the girder. The superintendent immediately took exceptions and did not want the elevation taken up in the girder, but it was finally decided to get three inches of it in the girder. Now the proposition comes up of raising the girder a little, and the engineers cannot agree on this. I do not believe that this convention can afford to recommend for use Style c, Fig. 4, on account of the additional cost of framing.

J. H. Markley.—In all cases on pile trestles I use Scheme a, Fig. 3. Now when elevating on steel girders, when timber was not so expensive with us, I used something like Scheme a, Fig. 4, but with oak timber running up to $28 per thousand, and fir about $30 to $35, I adopted Scheme c, Fig. 5, which I have used for eight or ten years. I put the longitudinal piece on and then cover it with galvanized iron. I would like to hear from some of the other members on this.

Mr. Rettinghouse.—I would like to hear from Mr. Jutton on this subject. He covers a large territory, and he has seen all kinds of superelevation.

Mr. Jutton.—One thing which might be considered when superelevation is put on steel bridges is that it is sometimes necessary to change the superelevation. If the superelevation is taken up in the cast bases or in the ties it is easy to change the amount of it if occasion requires, but it is not so easy to change if it is made up in the floor beam and stringer connections of through steel bridges.

In regard to pile bridges and frame bent bridges, I think that all will agree that Style a, Fig. 3, is the best. By this method the superelevation is taken care of in the pile cut-off and it does not require any special or additional material.

On steel bridges where the superelevation is put in the timber deck, I favor Style b or c, Fig. 4. I don't see any reason for using Style a, Fig. 4, because it requires more material than Styles b or c, and the results are no better. I do not like any of the methods shown in Fig. 5. The block under the ties catches a great deal of moisture and dirt, and soon decays, and it requires considerable work to replace it. Then again, if only a part of this superelevation block becomes soft, the other part remaining sound, it will produce a low spot in the track.

Style a, in Fig. 3, takes care of all pile and frame bent bridges, but I think that we should be more specific and say just what we recommend for each type of steel bridges, rather than putting them all in one classification.

Mr. Rettinghouse.—I cannot understand why scheme b in Fig. 4 is not considered preferable to scheme a because with the same size of original timber some of the objections as to the cost of framing would probably be removed. I have used the method as outlined in schemes a and b. Mr. Jutton spoke about girder bridges, but said nothing as to pile piers where the elevation of the cast bases cannot be considered. We have had a number of cases in my experience where it has been necessary that the superelevation be increased, and we have run against the same problem. In most cases I have adopted Style b.

Mr. Aldrich.—I am a thorough believer in having the superelevation in the structure, if possible. It does away with the elevation in the ties, but, of course, where the bridges are already built and where one must provide more elevation, he must get it in the ties. I do not approve of the use of a block. Our standard tie is 8x8, and of course circumstances will govern all cases. I think wherever it is possible the superelevation should be in the structure, if not in the bridge bases then in the floor system.

Mr. King.—In Scheme b, Fig. 1, with the I-beam girders that we use, the elevation is put in as shown in this figure, and referring to Scheme d, Fig. 3, we have a framed trestle bent shown there in contrast with the pile bents where the elevation is placed at the top, so that the strain comes close to the foundation. I do not favor the use of the elevation block for I-beam girders.

Mr. Rear.—We treat I-beam bridges the same as we do stringers, and we would follow Style a in Fig. 1, making our

bridge seat on the bevel. I believe Style a in Fig. 1, is the ideal system of having superelevation on a bridge, but that is only when the bridge is designed for a constant speed. Superelevation is figured for the maximum speed, and you will note that when a train is just creeping over the bridge, the line of load will be vertical and in that way will throw a cross load into the webs of the girders. Now if that train was running at the speed for which the elevation was computed, the load would travel down to the bridge seats in line with the webs, and that is the system we should have if we can arrange it that way; but we have trains that run 45 miles an hour over a bridge, and the next train will just creep over it, and that slow trip will put more stress into the girders than will the other train at speed. So in order to overcome the ill effects from difference in speed we should have the girders so seated that the load will come directly on line with the webs and not with a side component. I would advocate Style c in Fig. 4, in preference to a and b. I think that c presents the best appearance and it costs very little more, and it was adopted on the Harriman lines, by the engineers, representing 30,000 miles of railroad.

Mr. Markley.—What does timber cost in your country?

Mr. Rear.—We pay about $14.50 to $15, but I would say that we pay higher wages correspondingly, so that the smaller cost of the timber is offset by the higher cost of the labor. It strikes me that, from a practical standpoint, we should say what is best regardless of the cost.

Mr. Gumphrey.—The gentleman made an assertion about the distribution of the load with the elevation in the girder. The slow train in passing over the bridge, with the girder setting vertical, and all the bevel in the tie, will no doubt act the way he speaks, but I would like to have him explain what will happen in the case of the train running 45 miles an hour on elevation for a six-degree curve with the girders set that way. What action does that high-speed train bring upon the girders set vertical?

Mr. Rear.—This is hardly the place for a treatise on bridge engineering, but I think it is understood that it is easier to carry the stresses which would be given to the bridge by the centrifugal force down through the sway bracing, than it would be to carry them through the webs. You will understand that

beams usually have a heavy web, which is not skimmed down quite as close as it would be in a plate girder.

Mr. Penwell.—From my experience as a bridge builder for 25 years, I would say that so far as a pile trestle is concerned, Style a in Fig. 3, is the only plan I would consider. In our custom of handling girders on elevation, we would follow style a in Fig. 1. Now there might be cases where we might have to change the plan and divide the elevation between the bridge seat and the ties, the exact way of doing which would be left to the bridge engineer. When we get into cases of extreme elevation we let the bridge engineer decide at what limit we will stop tipping the girder.

In coming down to the tie, we have used Style a Fig. 4. In a through girder bridge I believe it is inconsistent to tip the girder. I would recommend Style c Fig. 4. It costs more, but it looks good to me, and should add strength to the tie.

Mr. Rettinghouse.—I move that we recommend for practice, Scheme a in Fig. 3, and Schemes a, b, and c, in Fig. 4.

Mr. Jutton.—As a substitute for that motion I move that we recommend for pile bridges and frame bent bridges Style a, Fig. 3; for I-beams and deck plate girders with a concrete substructure Style a Fig. 1; for I-beams and deck plate girders with a stone masonry substructure Style b Fig. 1; for through trusses, deck trusses and through girders, Styles a, b or c, Fig. 4.

Mr. Rettinghouse.—I second the motion.

Mr. Rear.—I am opposed to Style a, Fig. 1, for deck plate girders. I would hold out for Style c, Fig. 4, for a through plate girder and would like to see the motion amended to that effect.

Mr. Jutton.—Mr. Rear has stated that he considers that Style a Fig. 1 is the ideal way to get superelevation and I agree with him, because for a train going at high speed the load is applied in a line parallel to the webs of the beams or girders. However, it has the objection that for a train going at slow speed the direction in which the load is applied is vertical, and the girders which receive the load are set at an angle. On the other hand if the girders are set vertical and the superelevation put in the ties, the condition will be all right for slow-speed trains, but not for high-speed trains. The load from a slow-speed train is applied almost vertically, hence the girders are in the proper position to receive it. The load from a high-speed train is applied at an angle with the vertical because of the influence of the centrifugal force, and if the girders are vertical they are

not in a good position to receive the load. The question is, shall high speed or low speed trains determine the method of obtaining superelevation?

Mr. Rear.—I also stated that I-beams are heavy in the web. There is a waste of material in the web, and there is no objection to it on that account, but the web of a deck plate girder is always light, and it is much easier to take care of the side motion in the bracing, to carry it down to the masonry, where it lands at last, and we can do that through the system of sway bracing easier than we can carry it down through the light web of a girder. We know that a heavy freight engine with a heavy freight train behind it, running slow, is harder on a bridge than the high-speed trains. I would, therefore, move that the original motion stand as it is, with the words deck plate girder stricken out, and that deck plate girders be put in the same class with the truss and other bridges.

Mr. Jutton.—Instead of recommending Styles a and b, in Fig. 1 for all deck plate girders, how would it be to say deck plate girders 50 feet or less in length? I do not think that deck plate girders should be put in the same class as through plate girders and truss spans.

Mr. Rear.—I do not think we should specify a dividing line of this kind, but it is readily recognized that a deck plate girder is made for the economy of the material in its web, while beams are not economical in the web. The greatest stress will come in those webs, and I would not like to set any dividing line between the two. I would like to see the deck plate girders included with the through girders.

Mr. Jutton.—I will suggest then that we say deck plate girders of medium and short lengths instead of deck plate girders 50 feet or less in length.

President.—Will you please state your motion again Mr. Jutton.

Mr. Jutton.—I move that we recommend, for obtaining superelevation in pile bridges and frame bent bridges, Style a, Fig. 3; for I-beams and deck plate girders of short and medium lengths, Style a, Fig. 1 where the substructure is concrete, and Style b, Fig. 1, where the substructure is stone masonry; for deck plate girders of long lengths, through plate girders, through truss spans and deck truss spans, Styles a, b or c, Fig. 4.

Mr. Rear.—I second the motion.

Motion carried.

Subject No. 7.

BEST METHOD OF NUMBERING BRIDGES.

Secretary.—We have no regular report on this subject, but I have a letter from the chairman of the committee which I shall read. The letter follows:

I had hoped to be able to present a report on Subject No. 7, "Best Method of Numbering Bridges," by the time set for the annual meeting. I find, however, that I have been unable to make up my mind as to the proper method to be used, and therefore have been unable to get out a report at this time.

There are two number schemes in practice among the various railroads of the country for designating bridges; the one being the use of arbitrary numbers, beginning at a division point and extending over that division; the other, is the designation of bridges by the number of miles and hundredths of miles from some given starting point.

Both of these methods have their objectionable features. The method of giving numbers to the bridges does not designate the location of the bridge in any way. Thus, if you had a main line running from one to five or six hundred, and then begin on one of the branch lines with the next hundred beyond that—say 700, bridge No. 701, on the branch line, might be within a few hundred feet of bridge, say, 150 on the main line.

The second method of designating bridges by mileage distances was considered by this road (Chicago & Northwestern Ry.) some years ago, and at that time was not deemed practicable for a road containing several main lines starting from a given point, each of which had its numerous branch arteries.

I have collected some considerable literature on this subject and will respectfully recommend that the committee be continued to hold over until the next annual meeting, at which time it is hoped a full and comprehensive report can be made.

This subject, " Best Method of Numbering Bridges " is one

that has engaged the attention of nearly all of the roads in the country and I do not think we care to come out in a report until we have thoroughly and completely digested the subject and are able to make some specific recommendations.

I. F. Stern,
Chm. Committee.

President.—You have heard the reading of the letter, gentlemen, what are your wishes?

Mr. Staten.—I move that the report on this subject be carried over another year, with the same committee as this year.

Mr. Clark.—I second the motion.

Motion carried.

SUBJECT NO. 8.

WIRE GLASS IN ROUNDHOUSES, SHOPS AND STATION BUILDINGS.

REPORT OF COMMITTEE.

From a total of sixty-five circulars sent to members of the association, who have in hand the erection and maintenance of buildings in which wire glass is or could be used, the committee received fourteen replies. Of the fourteen replying nine reported that they do not use wire glass at all; two use it partially; two use it extensively, and one reports having stopped using it. Owing to the incompleteness of our information we do not feel that we are in a position to make any recommendations on the subject.

Wire glass costs about 50 per cent more than plain glass. It is less liable to do damage after being broken, on account of the wire preventing pieces from falling. Plain glass with a wire netting hung underneath, to prevent pieces of broken glass from falling, is not efficient, as the netting may rust away so quickly that its renewal is quite an item of expense.

Large sizes of wire glass are not economical: first, because of the additional cost of large sizes; second, because of the additional chance of large sizes being broken. Sizes 24 x 36 inches in skylights, and sizes 36 x 40 inches in doors and partitions should be economical sizes.

The gas and smoke from locomotives, because of its influence on the metal framework of train sheds and skylights of roundhouses, is the primary cause of the breaking of much glass. Contraction and expansion of metal frames is also a serious cause of breakage where glass is tightly fitted to the frames. Glass set horizontally, or at an angle breaks more readily than glass set vertically. Wooden bars for frames or sash are preferable to steel, on account of the effect of gases on steel bars; also there is less liability of breakage by expansion and contraction where wood is used. It is not practicable to use wire glass in roundhouse doors and windows, but it can be used in skylights and monitors of roundhouses, in train sheds and in roofs of shops, and in station buildings.

Wire glass windows and partitions in buildings will withstand extreme heat without breaking and falling out, and thus prevent the spreading of fire to some extent. Several fire chiefs from the larger cities have recommended that it be used wherever possible to do so.

Below is appended a copy of our circular of inquiry and replies to the same.

INQUIRY AS TO THE ECONOMY AND PRACTICABILITY OF WIRE GLASS IN ROUNDHOUSES, SHOPS AND STATION BUILDINGS.

1. Do you use wire glass in buildings under your jurisdiction?
2. To what extent?
3. Do you use rough, ribbed, or polished glass?
4. What is the relative cost of each?

5. What is the relative cost of wire glass to that of common glass of the same dimensions?

6. Is it practicable to use wire glass in roundhouse doors and windows?

7. What size and thickness of wire glass is economical to use in doors, windows and partitions where the glass stands vertical?

8. What size and thickness where the glass lies flat or at an angle, as on a roof or skylight?

9. What is the relative cost of maintaining wire glass, to that of plain glass of the same dimensions?

REPLIES.

D. A. Shope, A. T. & S. F. Ry.—I will state that on the Valley division, and I believe this holds good with the entire Coast Lines of our road, we have done away with the use of wire glass in our buildings. At one time we did use the wire polished glass, but for some reason the company discontinued its use and we are now using plain glass instead.

My experience with the use of wire glass has been limited, but I notice that where it is used in doors and windows it breaks the same as the plain glass. It is usually broken with nuts, bolts or some other hard substance thrown against it. In other words it receives the same kind of treatment as other glass does.

I believe that it is more economical to use the plain glass. While it may have to be replaced oftener, still it is cheaper. I would prefer the plain glass with a ⅝-inch wire netting over the window. This I find to be effective.

H. H. Pollock, P. C. C. & St. L. Ry.—As almost all glass around engine houses and shops is broken by flying pieces of steel, such as rivet heads, etc., I do not think wire glass would reduce the cost of maintenance, for it would certainly break under such conditions. We aim to use small size glass around our engine houses and shops, so that when a missile goes through the damage is small. Glass such as we use will cost about four cents per light.

Geo. W. Andrews, Baltimore & Ohio R. R.—We use a large amount of wire glass in buildings on this system, principally in skylights of train sheds, warehouses, stations, etc. Our main office building in Baltimore has all windows in the fourteen stories of polished wire glass, the sizes used running anywhere from 18 inches square up to 24 x 60 inches. The glass used is both rough, ribbed and polished; usually rough or ribbed on skylights and polished in doors and windows.

I consider it practicable to use wire glass in any opening where glass may be required. It is not economy to use it for all purposes, as the glass costs practically double that of plain glass.

We have experienced a great deal of trouble with wire glass, caused by cracks due to expansion and contraction, the cracks very often causing leaks, especially in skylights.

I believe this could be overcome in a great measure by allowing more space between the skylight bars, thus giving the glass room to expand.

My recommendation in this matter would be to use wire glass in all skylights, and in all buildings that it is desired to make fire-resisting. I do not think it would be economy to put it in buildings of a temporary character or in frame buildings, other than in skylights as first mentioned.

M. M. Barton, Pennsylvania R. R.—We use wire glass in train shed skylights and monitors, pier shed skylights and in buildings where fire protection is deemed necessary. We use the rough glass for skylights and monitors and polished article in doors and windows of buildings.

Rough wire glass 22 x 24 inches wide by 72 to 90 inches long and ⅜ inch thick, costs 22 cents per square foot. This is used in skylights on train

sheds, piers and freight houses. Rough glass (not wire) of same dimension sizes costs 13 cents per square foot. Polished plate of same dimensions costs 48 cents per square foot. None of this glass will hold an even thickness. Variations of 1-32 to 1-16 inch are frequent. Polished, wire and common plate glass in the trade is listed 1/4 inch thick, but varies the same as does the 3/8 inch thick rough. Polished 1/4 inch thick wire glass, in sizes up to 18 x 24 inches, costs 40 cents per square foot. Rough glass 23 x 23 inches by 1 inch thick in use on veranda over sidewalks, Broad Street Station, costs 70 cents per square foot. Florentine glass used in elevator door shafts and partitions, also figured rolled glass 1/8 inch thick with a variation of 1-32 inch costs 12 to 15 cents, per square foot. These prices are based on 1909 net quotations. At present there has been a sharp advance in the price of all glass, especially polished wire and plate, which have advanced 40 to 60 per cent.

It is practicable to use wire glass in roundhouse doors and windows, but I do not approve of its use for this purpose.

It is economical to use in windows and partitions where the glass is vertical. Panes not over 1/4 inch thick and in sizes up to 18 x 24 inches. When this size is exceeded the cost advances 75 to 80 per cent.

Since the liability to breakage in wire glass is less than it is with plain glass, I believe the cost of maintenance is less than it is with the plain glass.

E. E. Wilson, *Chairman.*

The following is copied from the Engineering News of April 21, 1904:

The problem of skylight construction for train shed roofs has long defied satisfactory solution by railway managers. Despite the purchase of the most expensive glass and the adoption of the most advanced methods of installation, the breakage and destruction of train shed skylights has entailed a large expense for maintenance and has caused no little worry for the safety of passengers and others using railway stations. While these broad facts are familiar to railway engineers there is little known in detail about the character and extent of skylight failures, and particularly about the causes which are responsible for the trouble. With the view of getting definitely at some of these details, one of the leading eastern trunk line railways recently appointed a committee of practical maintenance of way officials to investigate and report on train shed skylight failures and their remedy. This committee examined several important train sheds, among them the Jersey City station of the Pennsylvania railroad. Their report concerning this station was as follows:

Mr. F. S. Reynolds, representing the above station, states that the train shed at Jersey City was completed in 1891. The skylights installed were what is known as the "Helliwell" system, using imported steel bars, and American ribbed glass 1/4 in. thick, zinc caps and brass bolts, and the whole guaranteed for one year. The work was of such an unsatisfactory nature, as to warrant refusal for final payment. This train shed roof was especially designed to render it waterproof, but its failure in this respect necessitated the entering into a contract with another contractor, in 1894, for the sum of $12,000, by which he agreed to make the skylights watertight. In so doing he used an elastic cement, the glass being ribbed, with no protection underneath to prevent the fall of broken glass to the platform. The same contractor was awarded an additional contract of $4,000 for installing copper wire netting beneath for protection from falling glass.

Up to 1898, all the glass in the skylights was ribbed. From April 25, 1898, to March 30, 1900, there were purchased 1,740 lights of rough wire glass of various sizes ranging from 17 x 51 ins. to 22 x 52 ins. and from 1/4 in. to 3/8 in. thick; these were purchased for repairs. A three months' test was made of the glass in the train shed roof to find the percentage of breakage of wire and ribbed glass. A count was made on Aug. 8, 1900,

to find the amount of broken glass in the train shed. Out of 9,548 lights in the skylights, which constitutes 93 per cent of the whole, there was found 2 per cent broken, while of the wire glass, 746 in number, constituting 7 per cent of the whole, there was 13 per cent broken. On Oct. 1 the count showed 2.3 per cent of plain glass broken, and 14.3 per cent of wire glass, an increase of .3 per cent for plain and 1.3 per cent for wire, there being the same percentages of plain and wire glass as previously stated. On Dec. 12 the count showed 2 per cent of plain glass broken and 14.3 per cent of wire glass, there being no increase owing to the fact that 45 plain lights and 11 wire lights previously broken were replaced with wire glass. The bars in the train shed of the "Helliwell" system had become loose from the fact that the gases had eaten the hook bolts off that held them in place. In the spring of 1900 a wind storm struck the northwest end of the shed, blowing out a section of the upper skylight. As the bars that had been adopted from past experience, had been so unsatisfactory, it was decided to substitute a wooden bar, which to all appearances is very satisfactory. In this section wire glass was installed. In the spring of 1902 a section on the southwest corner was blown out in the same manner. In renewing this section, wooden bars and hammered glass 3/8 in. thick were used with copper wire netting 2 in. hexagon mesh No. 15 gage beneath.

At the present time there are in skylights 8,027 ribbed glass, 1,538 hammered glass, and 605 wire glass; the total being 10,170 lights. There are 413 broken. The percentages of the several kinds of glass broken are about equal.

On examining the train shed we found a section in the upper skylight, west end, 27 ft. 6 ins. x 156 ft., being removed on account of the dangerous condition of the bars. The glass removed is held in cases ready for replacement. We not only find the bars which were taken out of this portion of the skylights badly corroded and eaten away, but also the remainder of the steel bars in skylights are in a similar condition. Here we found a copper clip had been designed and installed to clamp the "Helliwell" bar down to the Z-bar to prevent the wind pressure from blowing out the skylights. Wherever this clip came in contact with the bar, the sulphurous gases have destroyed the bar at the point of contact, allowing the clip to fall to the platform. These clips we find were of an expensive nature, and proved unsatisfactory. We found that wherever they are taking out steel bars, they are substituting wooden bars with wooden caps, which we think should be of zinc. We found also that there is insufficient ventilation in this train shed to relieve it of smoke and gases. The conditions represented in F. S. Reynolds' report with reference to broken glass are fully borne out by our observations.

A letter was written to Mr. Reynolds in October, 1910, inquiring as to the condition of the glass in this same shed at that time and his reply is given herewith:

The train shed report on glass, published in 1904, which you quote, was given the attention which its character and importance suggested, and in consequence, I was authorized to adopt the recommendations of the committee in betterments of the Jersey City Station.

These betterments consisted of the complete renewal of the skylights, and necessitated the removal of the glass and supporting bars and their replacement with wooden bars to accommodate wire glass. The wooden bars 3 x 3 ins. square, of seasoned yellow pine, were coated with red oxide, placed transverse to the roof and fastened to the Z-bars with half-inch bolts at connecting points, and thereupon tapered white pine mullions were affixed to accommodate the glass, the tapering being designed to provide for the overlapping of the glass units. The pitch given this glass skylight was about 4 inches to the foot, in accord with the roof construction.

The work to which I have referred replaced the section 27 feet 6 inches x 156 feet, referred to in my report. The glass removed was quarter inch "rough" and "ribbed" plain glass, which, for economical reasons, were replaced upon the new bars. To obviate the danger of broken glass falling

to the platforms, we placed beneath it a No. 15 copper wire netting. The efficiency of this wire netting was soon destroyed by gases generated by the locomotives entering and leaving the enclosure.

This installation was made under my personal supervision and inspected at every opportunity with a view to determining its efficiency. I discovered, within a few months, that the glass fractured and threatened peril to those beneath and about, because of the failure of the copper wire beneath it. Thereupon, it became necessary to obviate this danger by replacing the plain, or wireless glass, with wire glass 1/4 inch thick, of the same dimensions, which dispensed with the copper netting beneath.

Rough wire glass, of 1/4 inch thickness, was installed in sizes 22 x 52 ins., embedded in elastic steam composition, and this material was also employed to weather the transverse joints which were capped with 1-1/4 x 2-1/2 in. white pine, mitered at the foot of each plate of wire glass and coated with good lead paint.

The behavior of this make of glass proved superior to the performance of the plain or wireless glass, but within a period of six months the crackage was considerable and increasing. This brought me to the consideration of a further reduction in sizes and increased thickness of wire glass and an investigation of the methods of its manufacture and its ultimate strength. In consequence, I required 3/8 inch thick wire glass in sizes 22 x 26 ins. made by the continuous process. This make of wire glass has replaced all of the skylights except the section above referred to—a total area of about 54,000 sq. ft. This area requires replacements of 1/4 inch wire glass frequently, whereas the area in which I have caused to be glazed the 3/8 inch thickness of "Continuous" glass, in sizes 22 x 26 inches, have proven very satisfactory, with the exception of a few cracked plates, which, upon investigation, I discovered was due to tight fitting.

In consequence, I shall hereafter have installed in this terminal, minimum sizes of "Solid-wire" glass embedded in "Elastic steam" composition, on wooden bars, with a full 1/8 inch space between the edges of the wire glass and the mullions—this space being filled with the "elastic steam" composition, for a cushion.

Upon inquiry, I learn that in this company's New York terminal, wire glass, in sizes 20 x 60 inches, has been installed, as also in the union station (Northern Central Railway) at Baltimore. Appertaining to the latter, I have secured the specifications and quote as follows:

> *GLASS:*
>
> Skylights of either type are to be glazed with 3/8 in. thick ribbed solid wire glass made by the "Continuous" process. The sheets must be held level, be of uniform color, free from flaws and be placed with the ribs on the under side. The skylight glass must not exceed 20 inches in width, and must have a full 3/8 in. surface bearing on each side for the full length of the glass. All edges must be clean and smooth and not chipped.

ROUGH

RIBBED

MAZE

POLISHED

FULL SIZE DETAILS OF WIRE GLASS.

DISCUSSION.

W. M. Clark.—We use wire glass in roundhouse skylights, and train sheds, but do not use it in wall windows or doors; in fact in our city we have an ordinance which requires wire glass in any skylight under which people are moving about or working. It keeps pieces of glass from falling, but outside of that wire glass is economical and for that reason I think it better. We use both the rough and the ribbed glass, but my experience about roundhouses and shops is that we have more trouble with our frames than we have with the glass. We have commenced to use copper in the frames, which we think ought to cut down the expense considerably, but are unable to tell until after used a couple of years. While using the common iron frames we had to renew our skylights every three or four years. We have no standard size of glass, but this is covered by the size of the skylight put in, usually from 20 inches up to 60 inches long, and from 12 to 30 inches wide. Our method in roundhouse wall windows, doors and partitions, where men are working and where pieces are flying, is to use small sizes, 12 to 14 inches, and some 8x10 inches. This is far more economical than to put in a larger light of glass, as when the light of glass is broken it is gone, no matter what the size.

Mr. Killam.—We use no wire glass, except in train sheds, and there we use galvanized iron frames. We did use wooden, but they are pretty much abandoned. We had trouble with the iron at first, but lately we have adopted a heavier metal frame, and we have very little trouble with leakage. We use common plain glass in other buildings.

W. M. Spencer.—I think this glass question is one of the most important that comes before this convention. It is a serious handicap with all of us, and it requires an immense amount of attention. I have no experience whatever with wire glass or metal frames. We have never used any.

Coming to the wooden sash and frame, it seems to me that if we adopted a system of using a much heavier sash, uniform in size, say 10x16, or 14, and then in placing the glass used a bead instead of putty, we would secure better results. Our people use all wooden sash, and plenty of putty, but it is expensive.

Mr. Killam.—We have found, in using putty in our roundhouses, that in two years the putty is soft, and one can pick it out with his fingers. We do not use the common putty; we mix it up with white lead, and that makes good putty. I think the glass in our roundhouses is about 18x30, or 24 inches. Since mixing white lead with the putty the glass seems to hold much better, but putty in a train shed is utterly useless. It is necessary to have a metal bead, and with that we have no trouble.

J. H. Markley.—It is probably known to but few what putty nowadays is made of. It is made of marble dust, and it is not worth putting in. In six weeks or two months, or even in two weeks, it will fall out. If we want good putty it is up to us to make it ourselves, with good whiting and linseed oil. Good putty, if put in right, will stay.

Mr. Staten.—We have had considerable experience with wire glass in train sheds, 8-ft. glass, running each way 24 inches, and there is nothing that looks worse than this. We have one place where it is patched up with rags, and other things. We went to work, and replaced some of this with ventilators, and I believe the train shed is lighter, and gives more ventilation than ever. It is not very expensive, and I believe we have just as much light as we did with the glass.

Mr. Rettinghouse.—It might be disgressing somewhat from the subject, but I think that the use of wire glass would be advisable in roundhouses providing heavier sash were used as suggested by Mr. Spencer. It has been my experience that most glass is broken by flying pieces. I have adopted for use the very system that Mr. Spencer advocates, and whenever making changes or building new roundhouses, or replacing sash in old houses, in windows or doors, I am now getting a sash with a space of one inch between the glass, and instead of putty, use small strips nailed on with brads, and it is noteworthy how the percentage of breakage has been decreased. We also use wire glass in our Hall signals. It was found that the use of common glass in signals is very expensive, due to boys throwing stones at the glass, or hunters using them as targets; and wire glass will stand a great deal of hardship, in that, while it will break, the glass will still remain, and permit the signal to operate.

M. F. Cahill.—Getting back to the subject of putty, nearly all engineers in designing a building make the great mistake of

putting in too large sizes of glass, and the cost of replacing such glass is great. An ordinary size, up to 10x18 inches, is very economical. There are two causes for putty falling out: one the poor quality, the other is that in all cases the wooden sash should be primed before putting in the glass. If the sash is not primed, the wood absorbs the oil, and the putty loses its life. If a little linseed oil is put in the putty and the sash primed the putty will last longer, and we will get better results. Putty is a very essential thing with us, and we use a great deal of it. I think that wood strips are very good, but where the glass must shed water I find it necessary to use putty.

Mr. Penwell.—I cannot give very much information on this subject, because we have no modern roundhouses, and I have had no experience with wire glass. Our roundhouses are all old, and we will soon have to begin rebuilding, but I have very little information, because of lack of experience with wire glass. I would like to mention the fact that the roundhouse is the worst place to keep a glass in, and that more are broken there than anywhere else. It is useless to try to putty a glass in a roundhouse. We make most of our own putty, but we do not apply it without painting, unless it is a rush job. If I can get the painters to put in the glass we always paint first, for it is useless to attempt puttying without.

The only protection we have for the glass is a wire netting, which we are experimenting with. I think, however, it is impossible to keep a careless fellow from breaking glass. There are men at certain shops who, if they want ventilation, will poke a boiler flue through a glass, and you cannot put in a glass that will stand that. One of the most practical things to do, therefore, is to reduce the size of the glass to an allowable minimum. Most glass that is broken in roundhouses is broken from the inside. When a window is hard to raise, some one is going to make a hole for ventilation. I dislike to say it in the convention, but we cannot get around it, and we might as well tell the plain truth, and let the responsibility rest where it belongs.

Mr. Scribner.—There recently came to our office a substitute for glass, a kind of so-called rubber glass. It is made on the order of wire glass, but instead of being hard like glass, it is flexible. I do not think this substance can be very easily broken, but it is not as transparent as glass: it is more opaque. It seems

to me this might be a good substitute in skylights, where no great amount of light is required, but for window lights, in doors, etc., I am of the opinion that it would not be satisfactory. The sample that I saw seemed to be sticky, so I believe that the only place it could be used would be in a skylight.

Mr. Lichty.—Is this volatile or not? Will it burn readily?

Mr. Scribner.—We applied a match, but it did not burn very readily. I doubt if a cinder would ignite it.

Mr. Rear.—I am not particularly interested in wire glass, but it strikes me that in trying to take out old panes of glass it is sometimes a pretty hard proposition, and that we do not need good putty around roundhouses. It also strikes me that panes of glass should not drop out on account of poor putty, because a liberal use of glazier's points will keep the glass in even if the putty did drop out. I would use more points, and would hope that the putty did not stick too tight.

I, myself, would advocate the use of wooden beads for holding glass in. I know, from observation, that a building is not as good in appearance with wire glass as with the plain article, for one will find a large number of wire glass broken, and they are not readily replaced, because they still keep out the weather, and, while they may be cracked, they still hold together, and the man in charge hesitates to go to the expense of putting in a new one while there is no opening there. I would not recommend wire glass in lower floors, or places where falling glass would hurt no one, but I would recommend it anywhere else.

A. H. King.—On the Oregon Short Line we are using wire glass pretty extensively, and I will say that, from a maintenance standpoint, we are having a great deal less trouble than we have had with the plain glass. We are using this for skylights, with metallic sash, and the size is from 18 to 24 inches wide and 4 to 5 ft. long. The usual method of setting them is to put on putty in first place, on the mullion or the frame, and set it carefully with good putty. The mullion consists of iron, the vertical section stands about an inch above the surface of the glass, and that is covered with sheet metal, which projects on the glass. I must say that in connection with skylights in engine houses and roundhouses, our troubles have been very much reduced since the use of wire glass.

SUBJECT No. 9.

STYLES AND DIMENSIONS OF HOOPS FOR WATER TANKS OF 50,000 TO 100,000 GALLONS CAPACITY.

The committee received a very generous response to the inquiries sent out and desires to express its appreciation and thanks to the members who rendered this assistance.

While the replies show a wide range as to experience and opinion, many of them are similar in certain respects, and all could not be shown separately in the report without making it too voluminous.

Four styles of hoops are being used for tanks of 50,000 to 100,000 gallons capacity:

1. Flat hoops,
2. Square hoops,
3. Round hoops,
4. Segmental hoops; also variously designated as half round, half oval, or half elliptical.

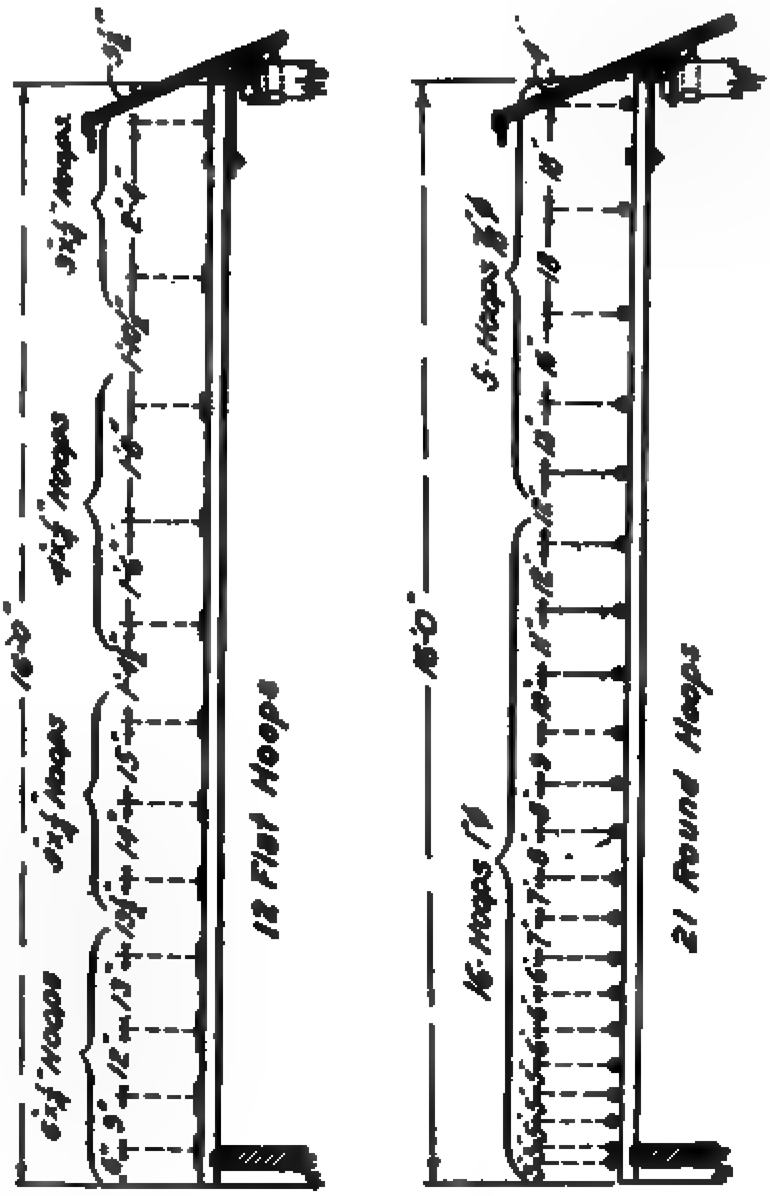
FLAT HOOPS.

Until quite recently flat hoops were used almost universally for tanks of all sizes. There are many who advocate this style as the best for the tanks under consideration, claiming that they have a more uniform bearing on the staves, do not crush the fiber of the wood, and if properly put on and cared for will outlast the staves. The Illinois Central R. R. cites an instance in which they took down a 100,000-gallon tank with flat hoops that had been in service 16 years. The hoops and also that portion of the staves under the hoops were found in perfect condition, and the tank was again erected at another location without any substitutions.

The experience of other members of the association has been quite to the contrary. Flat hoops have been removed after a comparatively short service, badly corroded on the inside, and also the staves under the hoops badly decayed. The location of the tank is quite a factor in the life of a hoop. If located at a terminal, perhaps next to an engine house or a clinker pit, the hoops will deteriorate rapidly, more especially those made of steel. There are also instances in which the kind of water in the tank is especially injurious to the hoops, and a location near salt water is also a severe test. In some cases the decay of the staves under the hoop seemed to be directly due to the rusting of the iron.

It is quite generally recommended that flat hoops be given two coats of graphite, asphalt or mineral paint before erection and that the staves also be painted at least one good heavy coat on the outside. Taking off the hoops and cleaning them on the inside is considered as an expensive operation and impracticable.

Flat hoops are the standard on the Ill. Cent. R. R.; L. S. & M. S. Ry.; T. P. & W. Ry.; Mich. Cent. R. R.; P. C. C. & St. L. Ry.; C. of G. Ry.; M. St. P. & S. S. M. Ry.; C. & S. Ry.; C. & N. W. Ry.; Boston & Maine R. R.; Nor. Pac. Ry.; Intercolonial Ry.; N. Y. C. & H. R. R. R.; M. K. & T. Ry.; P. & L. E. R. R.; and the Florida East Coast Ry., and they are strongly recommended by their representatives.



16'x24' TANK

No. Pcs.	Size	Length
3	[illegible]x3"	24'-8½"
3	[illegible]x3"	24'-9½"
3	[illegible]x4"	24'-10½"
6	[illegible]x4"	25'-0"
3	[illegible]x5"	25'-1"
6	[illegible]x5"	25'-2"
6	[illegible]x6"	25'-3"
6	[illegible]x6"	25'-4"

6 Lugs for [illegible]x3" Hoop
3 " " [illegible]x4" "
3 " " [illegible]x5" "
12 " " [illegible]x6" "

16'x24' TANK

No. Pcs.	Diam.	Length
9	[illegible]"	26'-2"
6	[illegible]"	26'-3½"
9	1"	26'-6"
12	1"	26'-7½"
12	1"	26'-8½"
15	1"	26'-9½"

15 Lugs for [illegible]" φ Hoop.
48 " " 1" "

Each end of hoops to have 6" thread and one square nut.

18'x26' TANK

No. Pcs.	Diam.	Length
27	[illegible]"	29'-0"
24	1"	28'-11"
18	1"	28'-10"
15	1"	28'-9"
18	1"	28'-7"

27 Ticklenus lugs for [illegible]"
75 " 1"

Each end of hoops to have 6" thread and one square nut.

Standard Flat and Round Hoops, C. M. & St. P. Ry.

There is a great variation in the dimensions of flat hoops. In thickness they run from 1/8 in. to 3/8 in., and in width from 3 to 6 inches. Some roads use a uniform thickness and vary the width; some use a uniform width and vary the thickness, while others use various widths and thicknesses. There is also much variation as to spacing, but for obvious reasons the wider and thicker hoops are placed near the bottom of the tank and the narrower and lighter ones toward the top, placing the lower hoops quite close together and widening the spaces as they approach the top. On the Florida East Coast Ry. all the hoops are of the same size, namely 3-16 x 3 inches and the lower 6 hoops are put on in pairs.

In recent years it has not always been easy to obtain wrought iron flat hoops, and therefore steel hoops are used. Steel hoops are found to be quite brittle, and quite often break while being tightened, or as the result of the swelling of the tank, or on account of unusual weather conditions. The most serious objection is that they corrode more easily than wrought iron.

Galvanizing of steel hoops, lengthens their life, but does not eliminate the brittleness, and many claim that the galvanizing covers surface defects that would otherwise cause the rejection of the material. When galvanized hoops are used, they should be inspected before and after galvanizing.

ROUND HOOPS.

Round hoops have come into use only within the last few years and seem to be proving very satisfactory. Wrought iron is considered the best material, and is more easily obtained in this form than in the flat shape. Mild steel is sometimes used in the round hoop as well as in the flat hoop, but the same objection as regards brittleness is present in both cases.

One argument in favor of the round hoop is that fully 90 per cent of its surface is exposed to view; deterioration is more easily discovered and painting is more effective. With the flat hoop at least 40 per cent of its surface is next to the staves and is practically inaccessible.

A number of railroads, such as the P. & R. Ry.; M. & St. L. Ry.; L. & N. R. R.; W. & L. E. Ry.; C. M. & St. P. Ry.; and L. E. & W. Ry., are using round hoops exclusively in the construction of new tanks. The M. & St. L. Ry. is also using round hoops in repairing old tanks, either by adding them to make the tank safer or substituting them for worn-out flat hoops.

It is claimed that because the round hoop has less bearing surface on the stave, it crushes into the fiber and not only weakens the stave, but induces decay. Others who have had experience say that if the hoop is properly put on there is no appreciable crushing of the fiber.

The round hoop forms a ledge or pocket on the upper side which allows the accumulation of dirt, cinders and moisture. Some claim that this is not a serious matter, because the sun and wind evaporate the moisture before harm can result. It is also claimed that where flat staves are used the hoop does not touch the center of the stave and moisture is not retained. This may depend on whether the wood is soft or hard, because some tanks have been examined that showed no such drainage space. On the W. & L. E. Ry. it is the practice to calk the round hoops with oakum and fill the top space with roof cement to shed water and also to protect the hoops.

SQUARE HOOPS.

The committee received no report from any railway that is using square hoops as a standard. The Ill. Cent. R. R. has one tank equipped with hoops 3/4 x 2 inches which may be called square hoops for all practical purposes, that have been in service for about 20 years, and the hoops, which are of wrought iron, show no great signs of deterioration.

Mr. E. L. Loftin, of the Vicksburg, Shreveport & Pacific Ry., writes

Standard Tank with Round Hoops, Chicago, Milwaukee & St. Paul Ry.
100,000 Gallons Capacity.

that his company uses steel tanks entirely, but that a great many wooden tanks with square hoops are used in that part of the country. The hoops are from 1⅛ in. square to ¾ in. square, put on in three sections, with lugs similar to those used with round hoops.

SEGMENTAL HOOPS.

This style of hoop has one flat side and does away with the objection to the round hoop of crushing into the wood and of collecting and holding dirt and moisture. It has all the advantages of the flat hoop with the added one of being narrower for the same strength, and because it is heavier at the center, is not weakened so quickly by corrosion. The N. Y. C. & H. R. R. R. has used half round hoops for tanks on some of its divisions, but has given us no information concerning them. The Southern Indiana Ry. built a 20 x 30 ft. tank with segmental hoops the past summer and is well satisfied with it. Material of this section is a standard shape and is carried in stock; hence, it does not have to be specially rolled.

LUGS.

Flat and segmental hoops are fastened or brought together by pairs of lugs made of either cast or malleable iron. In some cases the lugs are riveted to the ends of the hoops, while in others they are clamped on by a wedge which is assisted by a slight kink near the end of the hoop. The pair of lugs is then brought together by either one or two bolts or, more properly speaking, by rods with nuts at each end; and in this way the hoop comes into proper contact with the tank.

Another form of lug that does away with the riveting is in use on the Michigan Central R. R. By this method the hoop is bent to fill a hollow in the lug castings which are clamped together with "U" bolts.

The N. Y. C. & H. R. R. R. uses a style of lug that is rather interesting. The hoops are bent back upon themselves and welded. Through the loop thus formed a vertical iron rod 2½ inches in diameter is passed. Each end of this rod is drilled for a 1⅛ inch bolt. Two such bolts with 6 inch thread on each end are used to tighten the hoops. This method prevents any cocking up of the lug. (See illustration.)

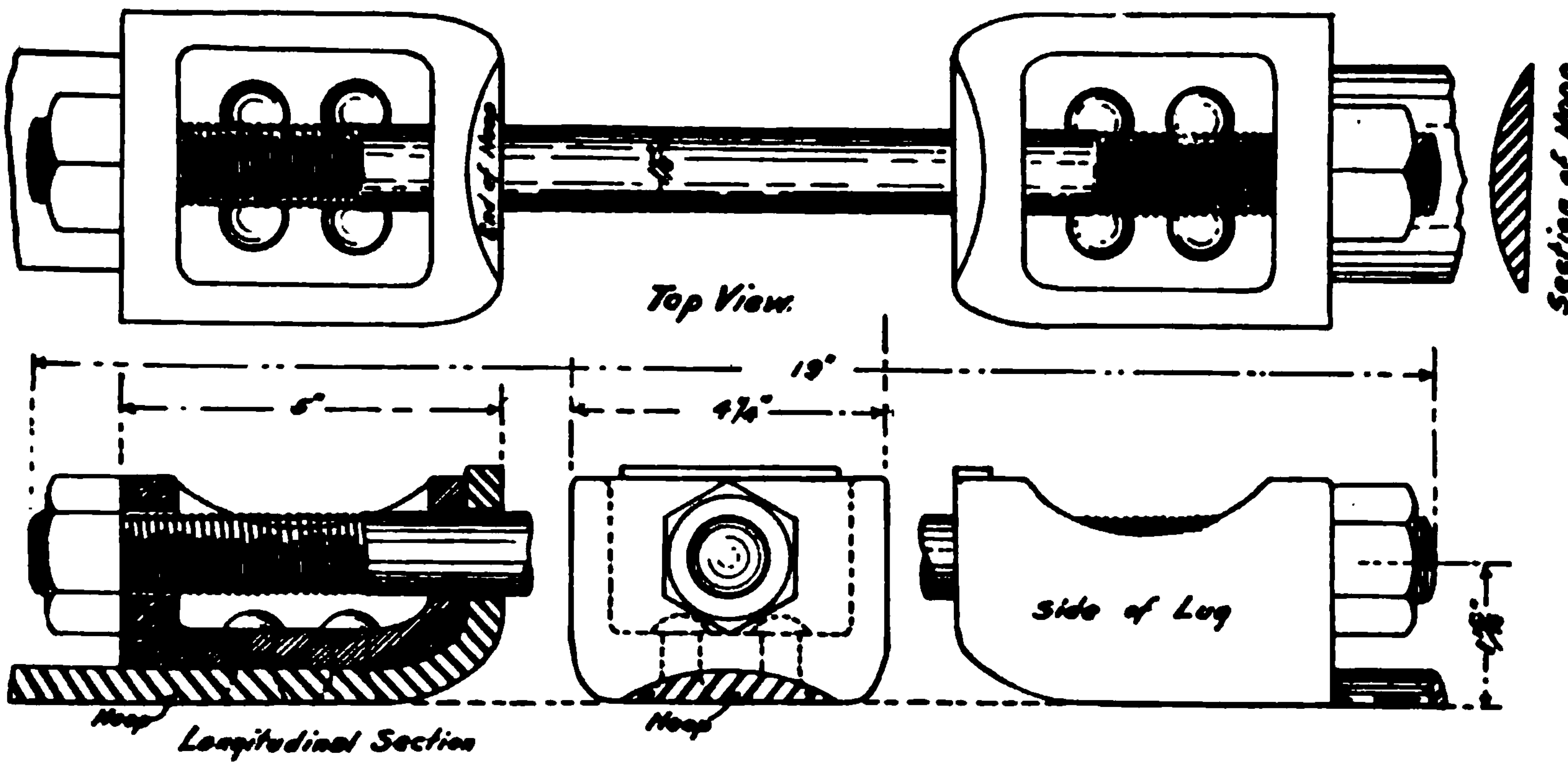
Segmental hoops are riveted to cast iron lugs. As used by the Southern Indiana Ry., the hoop is bent up around a rounded portion of the lug and a hole is punched through it, so that the bolt passes through both lug and hoop.

Square and round hoops are brought together by very simple lugs made up of a single casting having two lateral holes through which the threaded ends of the hoops are passed and fastened with nuts at opposite sides. The hoop is brought into the required contact with the tank by tightening these nuts. This simple lug and the way in which it is applied is one of the arguments in favor of the round hoops. The lug adopted by the Louisville & Nashville R. R. as its standard is the style generally used.

SECTIONS OF HOOPS.

It is the usual practice in tanks from 20 to 30 ft. in diameter to have the hoops in three sections, although there is some difference of opinion as to what is best. The Colorado & Southern Ry., L. E. & W. Ry. and the P. & L. E. R. R., use two sections. The Michigan Central and Wheeling & Lake Erie Ry. use four sections for tanks 30 ft. in diameter. There are others who apply the lower and heavier hoops in four sections and those above in three, and sometimes two, sections. The two-section hoop is difficult to erect, and by using more sections the stress on the staves can be more uniformly distributed.

It is quite generally recommended that the tank should have one or two good coats of paint on the outside before the hoops are applied, and



Dupree Segmental Iron Hoop.
Chicago, Terre Haute & Southeastern Ry.

MISCELLANEOUS NOTES.

that the hoops should have one good coat of mineral or graphite paint on the inside and two coats, if practicable. The outside of the hoop should be painted with the same kind of paint, and as frequently as the remainder of the tank, at intervals varying from 3 to 5 years.

A tabulation of the practice of various railway companies regarding tank hoops will be found an interesting study.

Mr. J. H. Markley of the Toledo, Peoria & Western Ry. has frequently found that hoops rust more rapidly on tanks which are allowed to overflow than those which are provided with overflow pipes.

The Minneapolis & St. Louis R. R. has discontinued the use of flat hoops entirely and are using round hoops for making repairs as well as for new tanks.

The Intercolonial Ry. of Canada rivet their tank hoops and drive them on in the same manner that hoops are driven on a barrel.

The New York Central & Hudson River R. R. has in service some tanks with round and half round hoops.

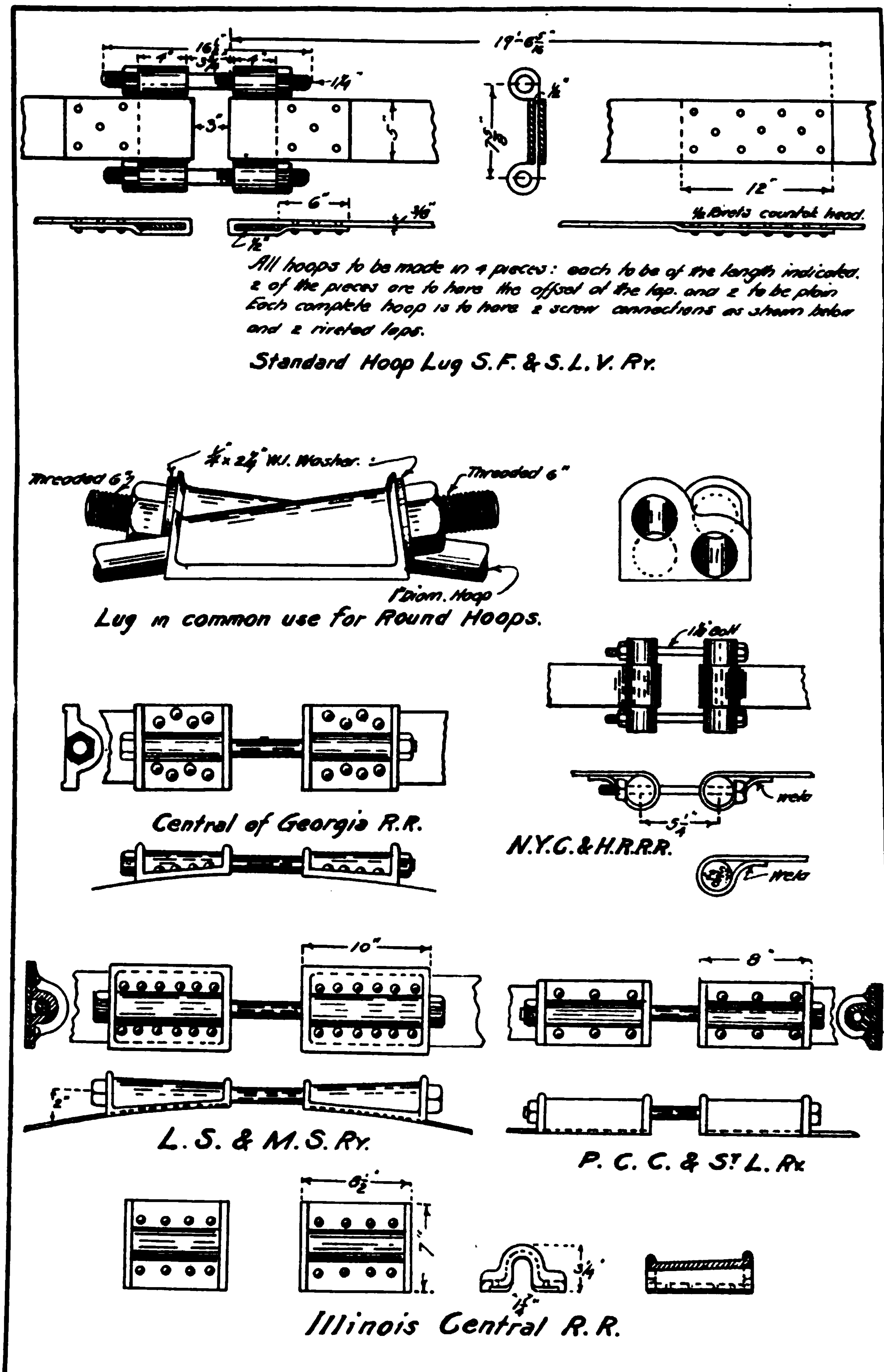
The recommendation of our association will assist the members in convincing the purchasing agents of the various roads that the extra cost of wrought iron hoops is a profitable investment.

Roads whose requirements are sufficient to warrant a special rolling of tank hoop material can procure the wrought iron hoops, but the smaller roads are usually obliged to purchase what the manufacturers of tanks have to offer.

CONCLUSION.

The committee has endeavored to make an impartial report of conditions as found. We do not feel that the association should make a definite recommendation as to the best style and dimensions of tank hoops. So many factors enter into the durability of tank hoops, such as material, kind of water in tank, proximity to engine terminals, manufacturing plants, salt water, etc., that the decision as to which hoop is best to use must be very largely a matter of personal judgment and familiarity with local conditions.

F. E. WEISE
C. E. THOMAS,
J. B. WHITE,
JOHN EWART,
JAS. DUPREE,
Committee.



Styles of Lugs Used by Various Railroads.

Standard Tank with Segmental Hoops, Chicago, Terre Haute & Southeastern Ry.

ROAD	Size of Tank.	Capacity Gallons.	HOOPS Style	HOOPS Total No.	HOOPS Diam. and No. of Each Size	HOOPS No. Sections	HOOPS Material	LUGS Material	LUGS Fastenings	LUGS Bolts.
Balto. & Ohio	16'x24'	50.000	—	13	1/4" and 5/16" x 4"	3	Wrot. Iron	W. I.	Riveted	Single
Cent. of Ga.	16'x24'	50.000	—	13	Two, 3/16" x 6." Two, 3/16" x 5½" Two, 3/16" x 5." Two, 3/16" x 4½" Five, 3/16" x 4."	3		C. I.	Riveted	Single
C. & N-W.	16'x24'	50.000	—	14	3/16" x 5"	3	W. I. and Steel	C. I.	Riveted	Dou. & Sin.
C. M. & St. P.	16'x24'	50.000	—	12	Four, 1/4" x 6." Three, 1/4" x 5" Three, 1/4" x 4." Two, 1/4" x 3"	3	Wrot. Iron	Mall.	Wedge & Kink	Double
	16'x24'	50.000	•	21	Sixteen, 1" Dia. Five, 7/8" Dia.	3	Wrot. Iron	Mall.		
	18'x26'		•	34	Nine, 1⅛" Dia. Twenty-five, 1" Dia.					
Colo. & Sou.		50.000	—	12	3/16" to 1/4" Thick.	2	Steel	W. I.		Single
		100.000	—	16	Three to Six Inches Wide	2	Steel	W. I.		Single
Fla. E. Coast	16'x24'	50.000	—	16	3/16" x 3"	3		C. I.		Single
Ill. Central	16'x24'	50.000	—	13	Five, 1/4" x 6." Four, 1/4" x 5" Four, 1/4" x 4"	3	Wrot. Iron	C. I.	Riveted	Single
	20'x30'	100.000	—	18	Eight, 1/4" x 6." Six, 1/4" x 5" Four, 1/4" x 4"	3	Wrot. Iron	C. I.	Riveted	Single
Intercolonial	16'x24'	50.000	—	12	Two, 3/8" x 6." Two, 3/8" x 5" Two, 1/4" x 4½." Two, 1/4" x 4" Four, 1/4" x 3"					
Lou. & Nash.	16'x24'	50.000	•	13		Up. 8=2 Sec. Low. 5=3 "	Low Carb. Steel	C. I.		
L. E. & W.	16'x24'	50.000	•	21	Eleven, 1." Six, 7/8." Four, 3/4"	2	W. I. or Soft S.	Mall.		
L. S. & M. S.	16'x24'	50.000	—	12	Two, 5/16" x 6." Three, 5/16" x 5." Seven, 5/16" x 4"	3	Wrot. Iron	C. I.	Riveted	Single
	20'x30'	100.000	—	16	Three, 5/16" x 6." Four, 5/16" x 5" Nine, 5/16" x 4."	3	Wrot. Iron	C. I.	Riveted	Single
Mich. Cent.	18'x30'		—	16	One, 1/4" x 6." Three, 3/16" x 5" Two, 3/16" x 4½." Six, 3/16" x 4" Four, 3/16" x 3"	4	Steel	C. I.	U. Bolts	Double

M.K.&T.	16'x24'	50.000	—	10	Two, 3/8" x 6". Eight, 3/16" x 3"	3	Steel	C. I.		
M.St.P.&S.S.M.	16'x24'	50.000	—	13	Two, 3/16" x 6." Two, 3/16" x 5½" Two, 3/16" x 5." Two, 3/16" x 4½" Two, 3/16" x 4." Three, 3/16" x 3½"	3		W. I.	Riveted	Single
N.Y.C.&H.R.		50.000	—	12	One, 3/16" x 4": Seven, ¼" x 4" Three, 3/16" x 4." One, 1/8" x 4"	3	Wrot. Iron	W. I.	See Sketch Welded	Double
Nor. Pac.	22'x30'	100.000	—	19	Twelve, 3/16" x 6." Two, 3/16" x 5" Two, 3/16" x 4½". One, 1/8" x 4½" Two, 1/8" x 3½"	3	Steel	C. I.		Double
	16'x24'	50.000	—	12	3/16" x 3" - to - 3/16" x 5"	4-2	Steel	C. I.		Double
P.& L.E.	16'x24'	50.000	—	13		2		W. I.	Riveted	Single
P.C.C.&St.L.	16'x24'	50.000	—	12	Four Inches Wide	3	Wrot. Iron	C. I.	Riveted	Single
Phila.& Read.	16'x24'	47.000	●	19	One Inch Diam.	3	Wrot. Iron	C. I.		
S.F.& S.J.V.	16'x24'	49.000	—	14	One, 3/8" x 5". Three, 1¼" x 4½" Four, ¼" x 4". Six, ¼" x 3½"	4		C. I.	Riveted	Double
Sou. Ind.	16'x24'	50.000	—	13	One, 3/16" x 5". Two, 3/16" x 4½" Two, 3/16" x 4." Two, 3/16" x 3½" Six, 3/16" x 3"	3	Wrot. Iron	C. I.	Riveted	
	20'x30'	100.000	—	17	Two, 3/16" x 6." Two, 3/16" x 5½" Two, 3/16" x 5." Two, 3/16" x 4½" Two, 3/16" x 4. Three, 3/16" x 3½" Four, 3/16" x 3"	3	Wrot. Iron	C. I.	Riveted	
	20'x30'	100.000	◓	17	Five, ½" x 3." Twelve 3/8" x 5"	4-3	Wrot. Iron	C. I.	Riveted	Single
T.P.& W.	16'x24'	50.000	—	13	Three, 5." Four, 4." Six, 3"	3	Wrot. Iron	C. I.		Single
W.& L.E.	20'x30'		●	18	Six, 1¼". Six, 1⅛". Six, 1"	4	Soft Steel	Mall.		
Some Parts of South.	16'x24'	50.000	■	18	1⅛" x 1⅛". ¾" x ¾"	3	Wrot. Iron	C. I.		

Table Showing Styles of Hoops and Lugs in Use by Various Railroads.

DISCUSSION.

Mr. Penwell.—I wish to state that I most heartily appreciate the report which has been read. I took down a tank that had been up 23 years which had flat iron hoops, and they were in good condition; I took steel hoops from a tank five years old, and put on these iron hoops in their place. Last summer we took down another tank that had been up 18 years, and found the flat, wrought iron hoops in perfect condition, and I took those hoops and put them on a tank that had been up for 12 years where the steel hoops were falling off.

I mention this as an argument for wrought iron hoops. I care not whether they are flat, round, square or what shape, if we can get good wrought iron in the hoops. It is difficult to obtain. I put some round hoops on a tank some time ago, said to be soft steel, and in drawing them up with a monkey wrench a hoop broke at the end of the thread; it was a very dangerous thing. We have had some since which appeared to be all right. Our standard at the present time is a round steel hoop. Hard steel is dangerous to workmen, and should not be used on any tank. I tried to persuade our people to buy wrought iron hoops. We could well afford to put in special orders, and get wrought iron hoops and carry them in stock.

We always paint our tanks a thorough coat on the outside, and paint the flat hoops on the under side before applying—not only paint them, but clean them thoroughly with wire brushes, before applying the paint. I have taken down old tanks where the paint was still on the back side of the hoops, where they had been up for sixteen years. We had one of our men inspect a tank with steel hoops some time ago, and everything appeared to be all right. Within a week the hoops began to fall off, and on examination we found they were badly rusted on the inside. To my mind the material that is put in the hoop is more important than the shape. If I could use my own judgment and could spend the money, I would not consider anything but a wrought iron, flat hoop with a lug. One thing about a round hoop is that it is easier to bend around the tank than a flat hoop. Where our tanks have round hoops I instruct our painters to use a very thick coat of paint in painting around the hoops, to protect them.

Mr. Lichty.—I think we all realize that the old fashioned

iron hoop is better than those made of steel. A hoop that will last twice as long is cheaper in the end, and I do not see why, as long as we spend so much money for a water tank, we try to save $20 on the material in the hoops. I agree with Mr. Penwell that it is not so much the shape as it is the quality of the material, and I think the association should make some recommendations, and come to some conclusion in regard to tank hoops. The managements of the roads are looking for something in the way of results on this subject. There is no economy in using steel or any kind of metal that will break or rust away in a few years.

W. O. Eggleston.—I am greatly in favor of wrought iron hoops. I can cite cases of tanks that have been up 35 years and never had a hoop changed. One of these tanks is at a roundhouse, very close to a cinder pit, where it gets the fumes and gases from the locomotives, and they have had no effect on the hoops. These hoops were made in three sizes, $\frac{1}{8}$x5, 3-16x6, and $\frac{3}{8}$x7,—twelve hoops to the tank. I have taken the matter up with our people at different times, stating these cases, urging the adoption of a wrought iron hoop of this pattern, but without avail.

I have known of steel hoops breaking after only three to five years' service. I have known where we had tanks collapse that have been up only six or seven years, and I claim that it is a source of annoyance to use steel tank hoops. I believe this association has a right to recommend a standard hoop for water tanks, and I am heartily in favor of the old style wrought iron hoop, as it is cheaper in the end. I remember taking this matter up once before, and our people went to the U. S. Wind Engine & Pump Co. and got a report on steel hoops, and they claimed that was all that was necessary to settle the case. I believe we have a right to suggest a standard wrought iron hoop for tanks.

A. H. King.—I wish to go on record in favor of the flat hoop on water tanks. I noticed, in coming to the convention, a tank that was built at Laramie while I was on the Union Pacific, where flat hoops were used, and while I am not exactly sure as to the detail of the hoop, the size is somewhere in the neighborhood of $\frac{3}{8}$ by 5 inches that I used at the bottom, and the hoops are lighter as they go towards the top. The staves are California redwood, and it is my belief that there has

never been a hoop changed on that tank. We have another tank on the Union Pacific R. R. that was built in 1879 or 1880, and it has flat hoops, and on that tank we have never changed a hoop. While the timber is getting pretty soft, and some of it has been changed out, we have never had any trouble with the hoops. With steel tanks I doubt whether we will ever get any better results than that, and I want to say that we should take a positive stand on this question, and if it is the judgment of the others I should say we ought to go on record as favoring the flat hoop.

Mr. Rettinghouse.—This discussion this morning has brought out some wonderful records. I find that most of our tanks on the Northwestern do not last over twenty years, while most of them are taken down in about 16 years.

W. O. Eggleston.—In reply to Mr. Rettinghouse I will say that 35 years ago I helped to get out six tanks that were made of Pennsylvania pine, kiln dried. We worked them up in the shop by hand, every joint being made with a plane, and those tanks are perfectly good today.

I move that it be the sense of this meeting, that a wrought iron tank hoop be recommended to the railroads, through our proceedings, of such sizes as are deemed proper, with double-bolted lugs and wrought iron bolts.

Motion seconded.

Mr. Killam.—This tank question is one that is most interesting. On the Intercolonial Railway we have a number of kinds: we have some tanks with flat hoops that were put up by contractors (not from our side of the line), and I must say that these tanks were very poor. Our standard hoops are of Lowmoor iron, and we have some that have been on for 25 years; they are painted outside with two coats of white lead. The tank, before erecting, is painted inside and out, and when it is completed it is given another coat inside and out. The joints of the staves are painted with white lead, and then coated with tallow over the paint when sent out. These tanks are put up by our men, as we have never been able to get contractors to do this. We have tanks which have been built many years, and there is not a leak in them. There was one 80,000-gallon tank that was put up at St. Johns, on a 50 ft. tower. After it had been up for five years one of the men sent in a piece of one of the hoops which had fallen off. The manager of the water sup-

ply was notified of this, and said he would send a man down there the first of the following week; Sunday afternoon the tank burst. If it had happened on a week-day it would have killed many men. The hoops had been put together with lugs, and they had not been painted. They were steel hoops, when they were supposed to have been Lowmoor iron. After years of experience I think the riveted flat hoop driven on with a wooden maul, is the best. We have tanks put up in that way 35 years ago, and they are good yet.

W. M. Clark.—For the benefit of the association I will say that the Baltimore & Ohio R. R. has adopted a wrought iron hoop and we do not order anything else. I think that has been brought out by our fellow member, Mr. Andrews, who has always been an advocate of wrought iron hoops. Our tanks are all painted one coat thoroughly when received. After they are put up they are painted inside two coats and outside one coat. With steel hoops, it is necessary to renew them every ten or twelve years. On the division I am now with we have renewed the steel hoops on at least 12 or 15 tanks, but we hope from this on to have better success, as we are authorized to use only wrought iron hoops.

Mr. Penwell.—I believe every man in this room is ready to vote for wrought iron hoops, and I agree with them, but I am not so sure that this association should say what the size of the hoops should be.

Mr. Perry.—We use flat hoops, and our men think they are the best. We have been using flat hoops for years, and where we have used wrought iron we have never had a failure. Five years ago we put up a tank with flat steel hoops, and I think it was just about 1½ years, when the tank broke. Lately our people have adopted the round hoop, and we have had very good success with it so far, but I agree with you that we should have wrought iron hoops, whether flat or round. So far as the material in the tank is concerned, I think that pine lumber has a certain pitch that adds to the life of the hoops.

W. O. Eggleston.—At the suggestion of Mr. Penwell, I will withdraw that part of the motion relative to the size of the hoop.

C. E. Thomas.—In reference to the adoption of the flat wrought iron hoops, I think we ought to consider the question of how it came about that round hoops were used on water tanks. The insurance people brought this question up, because

they had some failures with tanks not in railroad service, but I doubt if those tank hoops were inspected as often as the hoops on our railroad water tanks.

On the Illinois Central R. R. we are using flat hoops entirely, one-fourth inch in thickness and four, five and six inches in width. We give them one coat of red lead on both sides at the time they are made, and before we erect them we give them another coat of paint on the underside. We are opposed to the round hoop for various reasons. We have at a certain point on our road a tank of 60,000 gal. capacity, that has been in service 20 years, equipped with ¾x2 in. hoops. The staves show considerable decay, but the decay occurs only in the vicinity of the hoops. If the staves will decay to this extent with a hoop of this shape I would like to know what would be the result in the case where round hoops have been in service the same length of time. These ¾x2 in. hoops which I have referred to are in service in the immediate vicinity of a round house, power house and cinder pit. They are made of wrought iron and show very little if any deterioration after 20 years service. We took down a tank of 100,000 gal. capacity 16 years old, which had flat wrought iron hoops, and erected it in another location using the same hoops. We have other tanks with wrought iron hoops which are 26 to 28 years old.

I am thoroughly convinced that a great deal depends upon the shape of the hoop as well as the quality of the metal. I believe that this association should take a stand against round hoops and recommend those of a flat or segmental shape, and that wrought iron be used instead of steel.

A. A. Wolf.—I must say that the question of tanks has been a very serious one with us for a number of years. For the past seven years we have been using a round hoop on new work and have used a number of these for repairs. Of course, if we could get the old charcoal wrought iron a good many of the imperfections would be eliminated. On account of the trouble we have had in trying to get wrought iron, we were finally forced to accept a grade of steel, instead of wrought iron. As it requires a special effort on the part of the iron works to manufacture that metal, it is practically out of the market. Last November I took down a tank that had been in service 36 years, but I do not think it possible to secure the same kind of metal now that was in the hoops that were on that tank. I cannot

see any valid objection to the hoop of round section. It is easier to inspect than the flat hoop; in fact you can see at a glance how much it has deteriorated, while the flat hoop deteriorates from the inside. Taking it as a whole, I am strongly in favor of the round hoop. We have a tank at our Milwaukee shop, erected five years ago, and we have had to renew every one of the flat hoops.

I do not know whether or not the kind of wood of which the staves are made would have any effect on the hoop. In other words, would the old hard pine stave cause the hoop to last longer than the California redwood or some other kind of wood? I would like to know if any one here has investigated, or has had experience with that class of wood under the same conditions.

Mr. Thomas.—I would like to ask if the last speaker has observed whether the round hoops adhere to the stave? and on what kind of tanks was your observation taken?

Mr. Wolf.—In reply, the tank is our standard 100,000-gallon tank, and to know definitely how much the hoop had imbedded itself in the stave, I loosened up one of them and found that the indention did not exceed 1-16 of an inch in seven years' use.

Mr. Thomas.—I had occasion, some time ago, to examine a couple of tanks at Memphis which were built with round hoops. One had water in it; the other they were just building. They were about 12x16 ft. in size and equipped with ¾ in. round hoops. These hoops set into the staves about 1-16 in. They put a ¼x4 in. flat hoop at the bottom of the tub, and upon inquiry I found that this was used to enable them to set up the staves better and get a good tight job. In the case of a round hoop in drawing the staves up tightly to the floor it would cut too deeply into the wood, hence they were using the flat hoop at the bottom.

Mr. Rear.—I think the time is hardly at hand to condemn the round hoop. I know of places where round hoops have been on tanks for years, and they are giving service, and I do not think we have had round hoops on tanks long enough to condemn them.

I am very strongly in favor of wrought iron hoops, whether flat or round. Another thing in regard to this, is that if a tank is poorly framed, there is an initial stress put into the rods, far greater than is necessary to hold the pressure of the water,

and in that way, some tanks may show round hoops imbedded in the staves to some extent. I believe California redwood would give good service on account of being soft. We have on one of our divisions probably a dozen tanks of California redwood, with wrought iron hoops that were put up 43 years ago. We are not building many more wooden tanks. We are using steel entirely, except for tanks where we treat the water. Where that is done the chemicals used are hard on the steel. We can put up steel tanks cheaper than we can wooden ones. We happen to be so situated that our tanks will not freeze, and probably in a cold climate the steel tank would be objectionable. I would suggest that the motion be left as it stands, and the matter of the shape of the hoop be left for a few years, until we know what these round hoops will do. I am, however, very strongly in favor of wrought iron.

Mr. Wolf.—Of course, in a great many of the tanks on southern lines where soft wood is used the round hoop might possibly be imbedded sufficiently to be a detriment, but where I work practically every tank is built of fir staves, and that wood is so firm that the question of imbedding does not need to be considered. Then, as another thing in connection with this matter of tanks, I hope that every member of this association will live to see the day when we will have no more steel or wooden tanks, but concrete. We are now in the reinforced concrete age, and I believe it will be only a few years before it will be universal practice to use concrete tanks.

J. Dupree.—This discussion has been very interesting, and I must take the liberty of saying something. Since our last meeting, at Jacksonville, this tank question has been a great study of mine. I was put on the committee, and made a study of it from every angle, and made all kinds of experiments and tests, and I have designed a hoop, which is, of course, another matter not to be considered here. But I agree with the others, that iron is the only material that should be used for hoops.

I have built quite a good many water tanks of fifty and one hundred thousand gallons capacity, but I was never satisfied with the style of hoops in use until we used the segmental hoop. The flat hoops are too thin and too wide. Their width is objectionable for the reason that they cover too large an area of the wood; then again, on account of the tubs, in most cases, being smaller at the top than at the bottom the

wide hoops do not fit as tight along the top edge as at the bottom edge, hence there is more or less of a space for small particles of cinders and dirt to collect back of the hoop so that when moisture and gases from engines combine with them it is disastrous to the hoop, more especially to those made of steel. Round hoops are considered objectionable by many for the reason that they have such a small bearing surface on the wood that the fiber is crushed, more especially with the softer varieties of wood. They also allow of a considerable space on the upper side for catching and maintaining water, cinders, etc.—perhaps a worse condition in this respect than that pertaining to the flat hoop. Mr. Penwell stated that some of their round steel hoops broke at the ends of the threads, which is liable to be the case with round steel hoops.

I am of the opinion that all of these objectionable features are overcome with the half-round or segmental hoops. They are only 3 inches wide, ½ inch thick, and have sharp edges which, when drawn up, fit snugly to the wood. They have a flat surface for the bearing on the staves; they are thick enough so that they can stand the loss of a considerable of their section by rusting and still have body enough so that they will not break, as is the case with the flat hoops. The lug-bolts pass through a hole in the ends of the hoops as well as the hoops being riveted to the lugs. The Chicago, Terre Haute & Southeastern Ry. (formerly the Chicago Southern) is using this style of hoop made of iron, and I think it is decidedly superior to any other, for the reasons which I have cited.

J. H. Markley.—Speaking about old tanks, I have one still standing that is 39 years old, and I suppose it will be 40 before we get it down. It has the original hoops on it, and it would be pretty hard to talk anything into my head but the old-fashioned wrought iron flat hoops. You cannot beat that record with round hoops. I put in two sets of steel hoops before I learned what they were. After that I quit using them. Nevertheless, one set of them is still in use; the other was taken off after ten years.

Another thing, we use too many hoops on our tanks. We should use a little heavier hoop and put them farther apart. The Chicago & Alton Ry., when they made their own tanks, used a flat hoop, and put them two feet apart, and they have a number of those tanks still standing which have been up for 25 years.

I also think the style of our tank should be changed. We still maintain the old-fashioned method of making it a little smaller in diameter at the top than at the bottom. Now that we are using a lug hoop, it should be the same size at the top as it is at the bottom.

SUBJECT No. 10.

FIRE-PROOF OIL HOUSES.

REPORT OF COMMITTEE.

The subject given us for investigation is, "Plans of Fire-Proof Oil Houses for Storing Large Quantities of Oil at Principal Terminal Stations."

At terminal and division points it is necessary to carry in stock a large quantity of illuminating and lubricating oils, and it is important that these should be so stored and handled that they may not be a fire risk in themselves or be liable to become ignited from fires which originate without. It is also important that the oil be kept free from grit and foreign matter, and that the method of handling it be such as to avoid all losses from waste, leakage and evaporation.

The storage should be of sufficient capacity to permit of emptying tank cars or barrels promptly and with as little labor as possible. The delivery of oil should be in charge of the regular storekeeper and be issued on requisition, so that it can be properly accounted for. This method of handling tends greatly to economy in its use. Consequently it is necessary that the oil house shall be near enough to the general store to permit of having the delivery pumps or faucets in the store room; and while it is possible to pump the oil a considerable distance, it is seldom possible to place the oil house at any great distance from other buildings, as the usual layout of terminals provides very cramped space for the necessary buildings.

The committee believes that buildings can be built and systems of handling devised which will permit the oil house to be placed anywhere that may be convenient without increasing the fire hazard, and several plans are shown which are good examples of such buildings.

The building itself should be of fire-proof construction, designed especially for the handling and storage of oil, and should be equipped with facilities for filling cans and barrels for shipment to small stations, and for the unloading of oil received.

The storage room should be underground, if possible, and should have concrete walls, floor and ceiling. The second floor and roof should be of fire-proof construction, but may be of concrete, brick or steel frame, with galvanized iron roof and walls, as may be desired. The fill boxes, pumps and drip pipes should be on this second floor.

The oil should be stored in suitable tanks of such a size as will permit of prompt unloading, whether delivered in tank cars or barrels. This permits cars to be released and barrels or drums to be returned without delay, and greatly reduces the loss from leakage.

The tanks should be dust-proof and should be placed low enough to permit of emptying the oil into them by gravity. If the drainage will not permit of placing the tanks below the ground level, it will generally pay to elevate the receiving track.

The tanks should be made of open-hearth steel with lap riveted seams and well calked. No substitute for calking, such as red lead paste, paper felt, etc., should be permitted, for in time they will dry or crumble and fall out, leaving a leak.

Before the tanks are put to use air pressure should be applied, to make

sure that they are tight; and man-holes with removable covers should be provided so that the tanks can be inspected or cleaned.

Indicators should be provided to show quantity contained, in gallons or otherwise.

The tanks should be equipped with suitable automatic vents to allow air to escape or be drawn in when filling or emptying, and those used for volatile oils, especially gasoline, benzine, naptha, etc., should have a special vent pipe run to the outside of the building and to a sufficient height to insure against evaporation. This will permit gases to escape in case of excessive heat, thus removing all possibility of explosion.

It is probably best practice to bury tanks containing gasoline, benzine and naptha, in the ground, or place them in a special vault outside of the regular oil house.

Where tank cars are used, supply pipes should be furnished leading from the cars to the tanks, a separate pipe being used for each kind of oil. These pipes should be permanently connected to the tanks and equipped with flexible connections to attach to cars. These flexible connections should be arranged so that they can be swung out of the way when not in use, and should be equipped with caps or valves to keep dirt and air out when not in use. Steam pipes for heating the oil in the cars may be necessary, and if so, should be provided.

If the terminal point furnishes oil to smaller stations, steel barrels or drums should be used, and separate pumps or faucets should be provided for this service; but the committee is of the opinion that the best method of supplying oil to small stations is by a supply car equipped with tanks of sufficient capacity, and by pumping the oil through hose direct to the tanks in the local oil house. This method is in use on several large roads, and they report a large saving from loss by waste and leakage, which is bound to occur in shipping oil in cans or barrels.

For making small deliveries of oil to engines, mechanics, etc., the best method is to use an automatic measuring pump, one having a continuous meter being the best. Several very reliable pumps for this purpose are on the market.

For filling barrels or large cans the oil can be handled by hand or power pumps, or by the use of compressed air. While it has generally been believed that the use of compressed air for handling illuminating oils is objectionable, on account of deterioration caused by moisture in the air, there is a strong opinion on the part of storekeepers and practical men that the use of air does not deteriorate the oil for practical purposes. Several roads use air pressure in some part of the handling of all their oils, and seem convinced that if there is any deterioration it is not to such an extent as to be noticed by the ordinary observer. Air pressure is of particular advantage in handling oil from supply cars, as the air can be taken from the train pipe, and other power is not likely to be available.

General plans of oil houses, with several detailed plans, as used by different railroads, are annexed to this report.

Some of those received which are not shown in the illustrations may be described as follows:

The Lehigh Valley Railroad submits plan of house 47 x 55, with concrete basement and side walls; main floor of concrete, reinforced with T rails; wooden frame roof 1/4 pitch, supported on wooden trusses, and covered with 3-ply composition granite roofing.

The Atchison, Topeka & Santa Fe Ry. sent in a plan of combination store and oil house at Topeka, Kansas, 50 feet by 150 feet, with 31 tanks in the basement, varying from 220 to 10,000 gallons capacity. It has a covered platform 20 feet wide along one side of the building, the entire length. The house is built of fire-proof construction throughout. The basement walls and floor are of concrete, and the main floor of reinforced concrete. The materials in the side walls and the roof are not described.

Mr. N. M. Rice, their general storekeeper, describes their system of handling oil as follows:

"From our new oil house at Topeka is handled the entire supply of lubricating and illuminating oils for the Santa Fe system. We have a storage capacity of 150,000 gallons, which includes paints and oils such as raw and boiled linseed oil, turpentine, etc. We have 31 storage tanks with 31 long distance self-measuring pumps of the S. F. Bowser make. In fact, the plant complete was installed by the Bowser people. We also have seven steam pumps with which oil is transferred from one tank car to another. All of our oil on the Santa Fe System is handled in tank car lots with one or two exceptions. We have storage tanks of sufficient capacity for two or three months' stock at practically all of our terminals.

"With this new improved oilhouse and storage plant at Topeka it enables us to transfer oil from Union Tank Line cars to our own at Topeka, thereby cutting out the mileage and per diem charges on foreign cars. Under the old system the Union Tank Line cars were sent to the farthest point, Richmond, Cal., on our system or south to El Paso and Galveston, and by the time the car was returned home we had from $25 to $35 charges covering the car. We have cut out this extra expense and have 25 cars of our own in service for handling of headlight, mineral seal, signal, engine, car and valve oil. We can transfer 200,000 gallons in ten hours at this plant.

"At the outside terminals we have what is known as the combination oil and storehouse. We have discontinued building the old style oilhouses separate and distinct from the storehouse; instead, we build a concrete basement under the storehouse platform ranging from twenty to one hundred feet away connected up with the Bowser long distance self-measuring pumps, placing the pumps in the end of the storehouse so that the man issuing the material and supplies can also take care of the oil department as well. By this arrangement we have eliminated the first cost of the oil house and have reduced the cost of handling by reason of the combination which does away with the special men that would have to be employed to take care of the oilhouse, which means one during the day and one at night. We might say from $90 to $100 per month decrease in handling by reason thereof.

"The delivery of oil to stations is handled from the supply car direct. We have storage tanks at each station based on their issues and the stock is replenished monthly from the supply car which is equipped with a hose connection so that we can fill the storage tank in two or three minutes. By this system we do away with the two, five and ten gallon cans. This system seems to be very satisfactory indeed by reason of cutting out entirely of local shipments.

"We have the Bowser System of self-measuring and metering pumps at all points and since their installation we have been able for the past two years to show a slight overage in each of the different grades of oil. Prior to this time we were, at the end of each year, from one to three per cent short."

The Intercolonial Ry. furnished a plan of an oilhouse at Halifax, 30 feet by 50 feet, of fire-proof construction throughout. Basement floor and side walls concrete; main floor, reinforced concrete 4½ inches thick, supported on 15-inch I beams, side walls of main room, brick; roof made of 3½ inch reinforced concrete slabs on 9-inch I beams, pitched both ways from middle, 1 inch to 1 foot; height of basement, 9 feet; height of main room 10 feet. This building has two center columns, composed of I beams.

The Chicago, Rock Island & Pacific Ry. sent in a very neat and elaborate set of detail drawings of their No. 2 oilhouse 20 feet by 40 feet, the general plans only of which are shown in our illustrations which will suffice to show the kind of construction.

The St. Louis Southwestern Ry. have a brick oilhouse as follows: Size, 30 feet by 80 feet; basement walls, concrete; composition roof laid on 2-inch decking, supported on 2x4 nailing strips, on top of 7-inch longitudinal

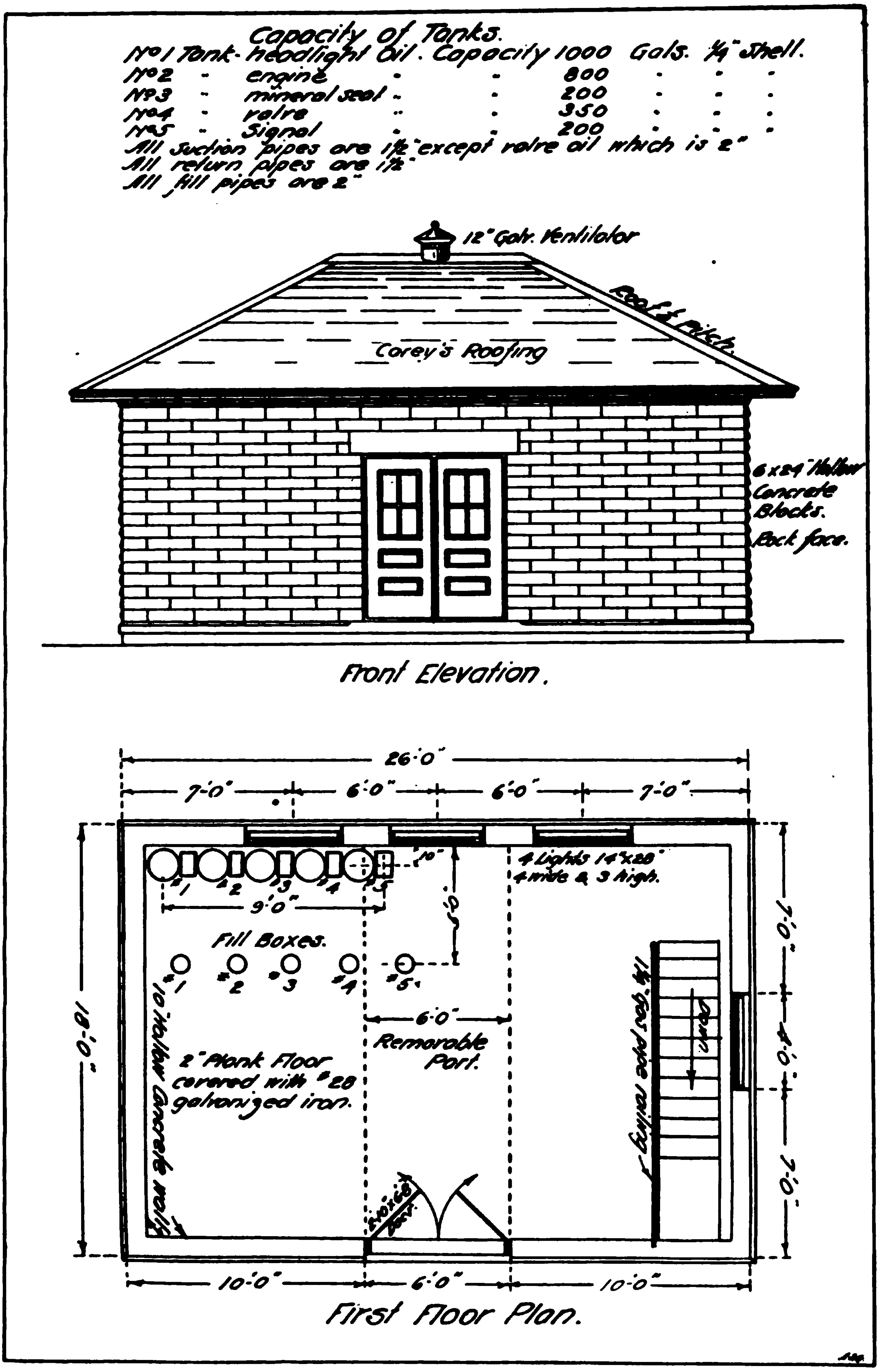
channels which are laid across riveted steel trusses, having no center bearings. The roof trusses are 16 feet and the channel supports about 3 feet, 6 inches apart.

The Missouri, Kansas & Texas Ry. have an oilhouse at Denison, Texas, 32 feet by 42 feet, after the same general design as that of the St. L. S. W. Ry., described above, except that roof construction is built up of wood, and covered with tar and gravel or composition roofing.

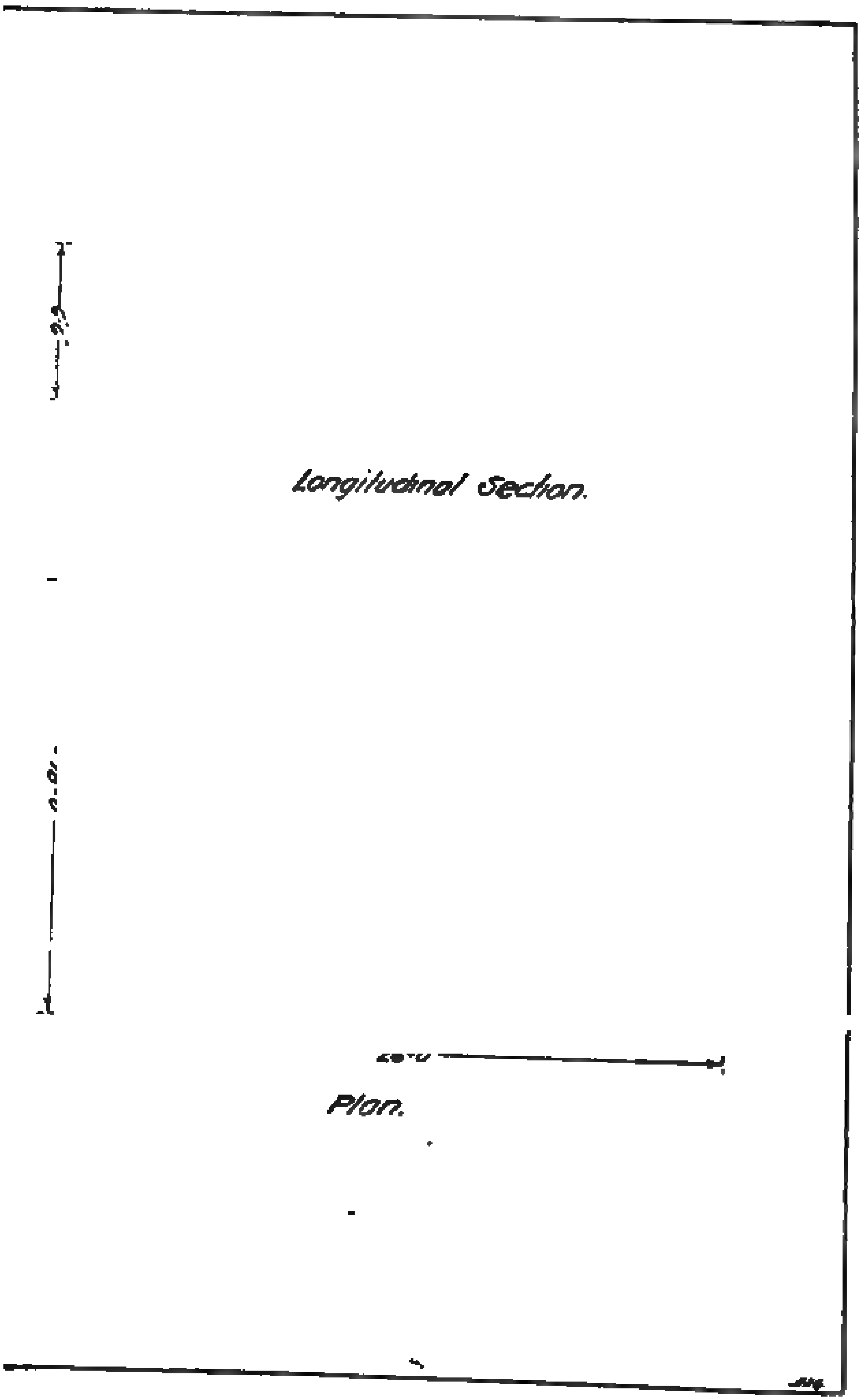
The Chicago & Northwestern Ry. have a number of oilhouses built of brick on concrete foundations, with tar gravel roof supported on a wood decking laid over wooden rafters. These houses are built separate and a short distance from the store houses, connected with a concrete conduit which contains the pipes leading from the oil tanks in the basement of the oilhouse to the storeroom where long distance pumps deliver the oils.

Attention is called to the fact that some of the plans submitted do not comply strictly to the term "fire-proof," having more or less wood in the construction of the roof. While the M. St. P. & S. S. M. house is of that character it has a sheet-iron protected ceiling which reduces the fire risk to a very great extent.

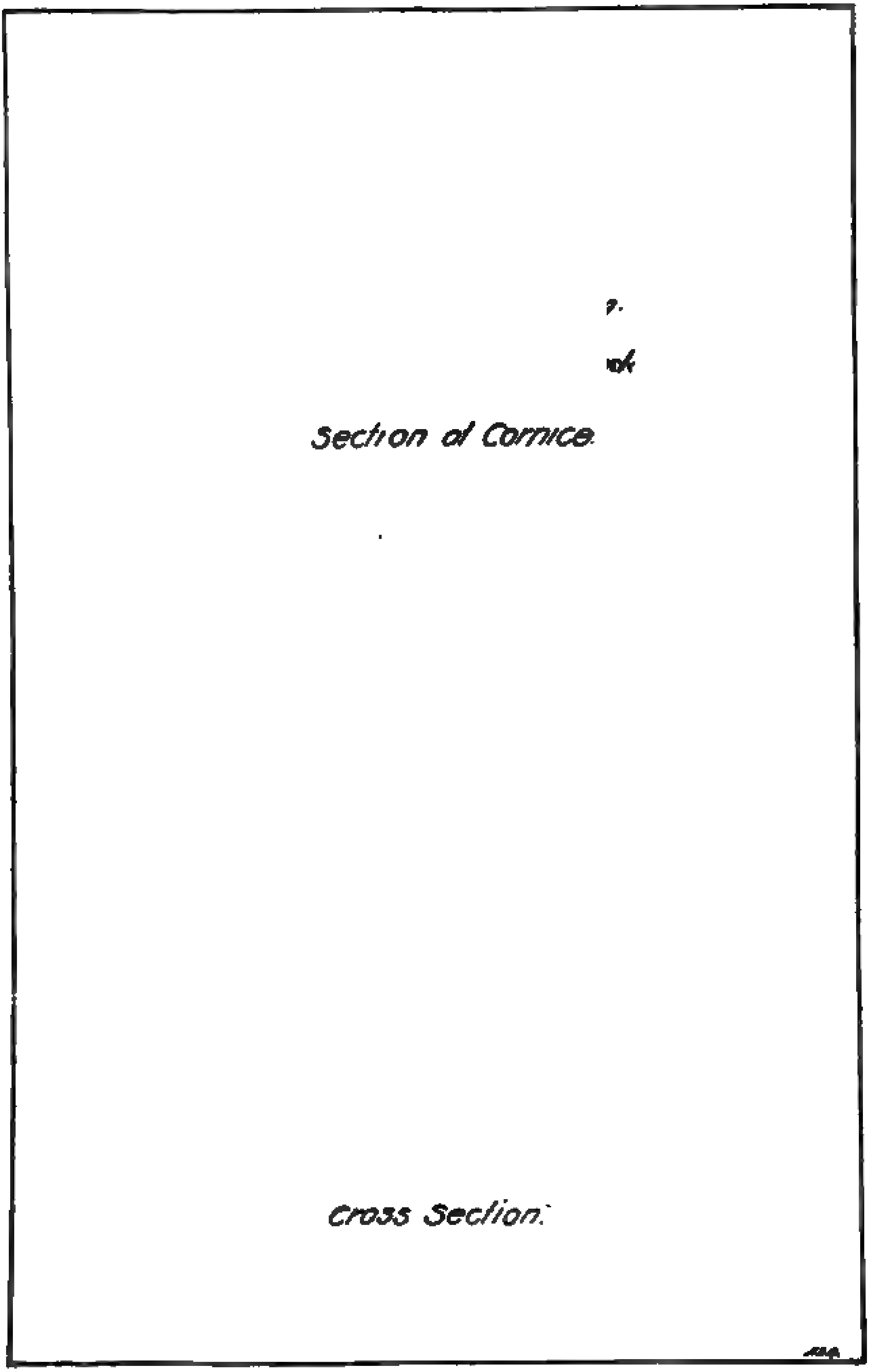
G. W. Rear, *Chairman.*
F. Ingalls,
E. R. Floren,
D. Robertson.



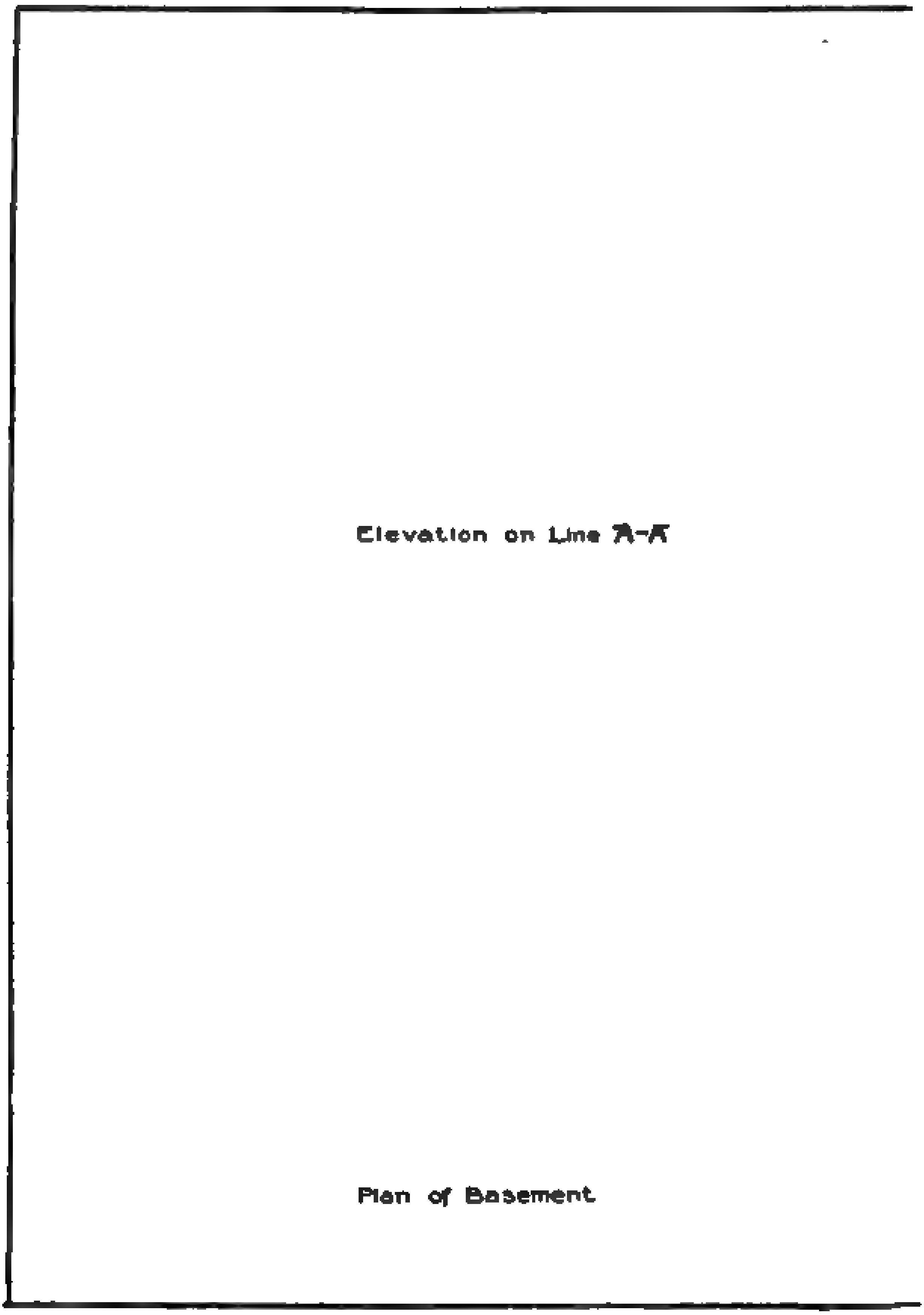
Standard Oil House, M. St. P. & S. S. M. Ry.



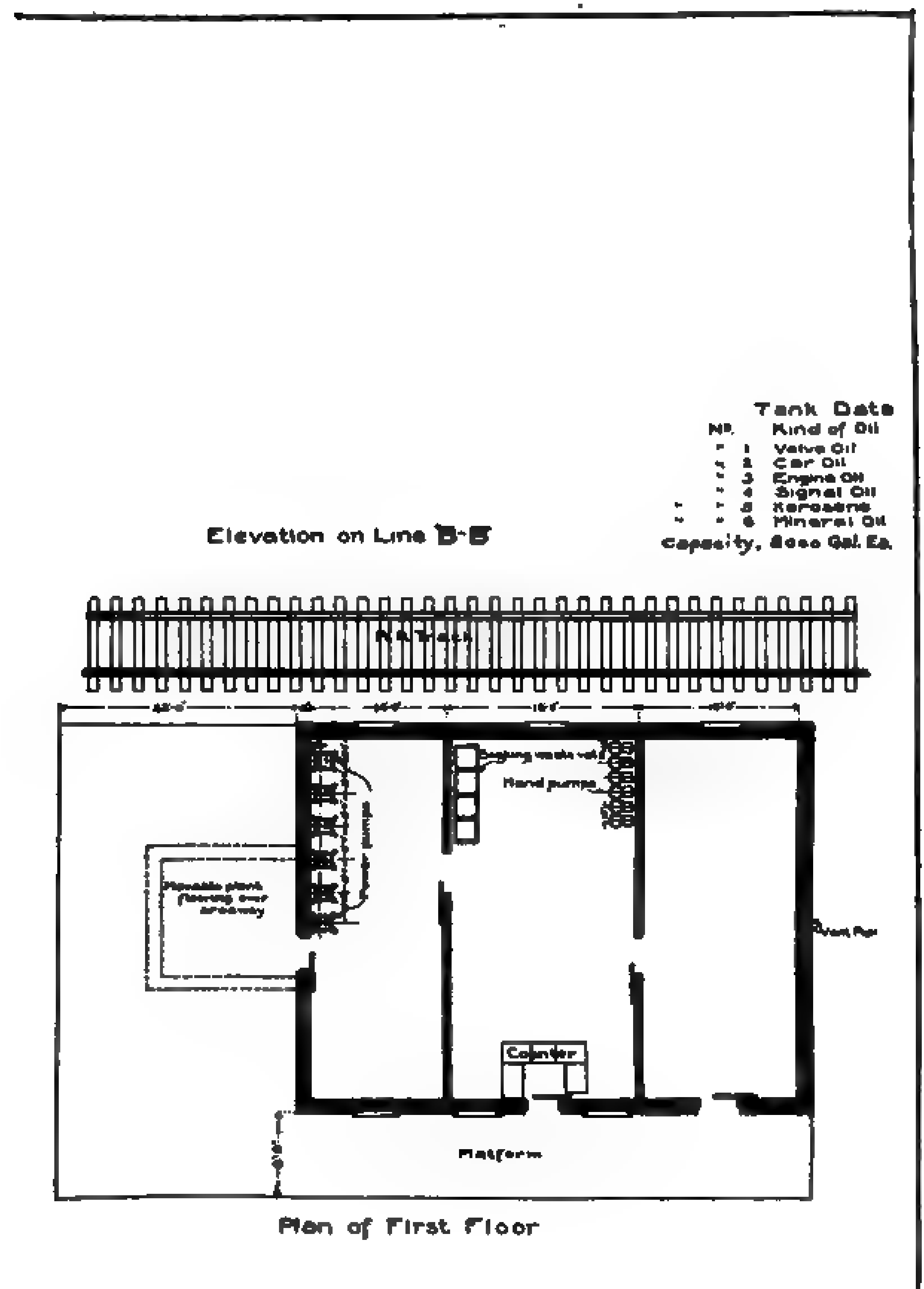
Standard Oil House, M. St. P. & S. S. M. Ry.



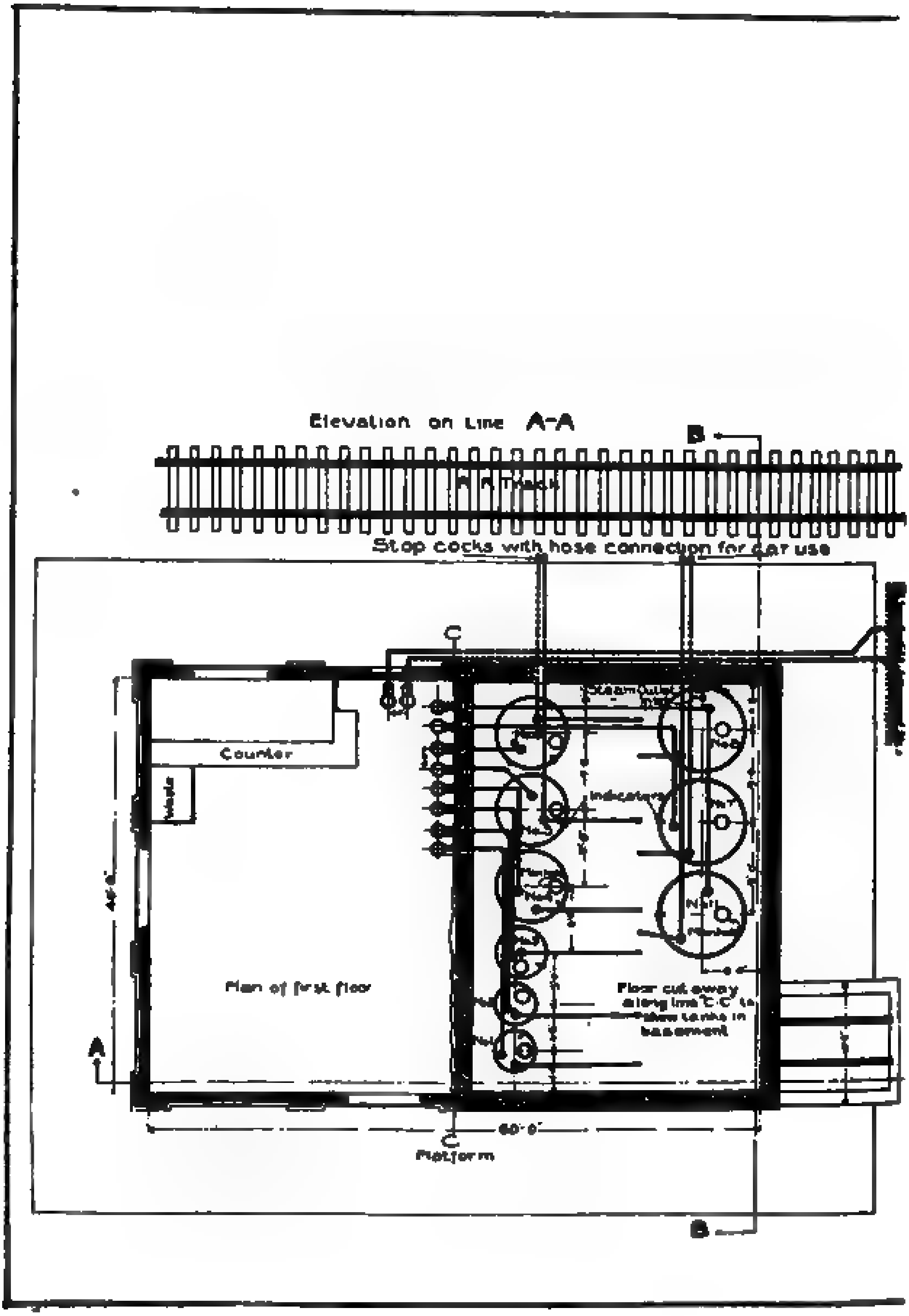
Standard Oil House, M. St. P. & S. S. M. Ry.



General Plan of Oil House Containing Six Tanks of 8,000 Gallons Each.

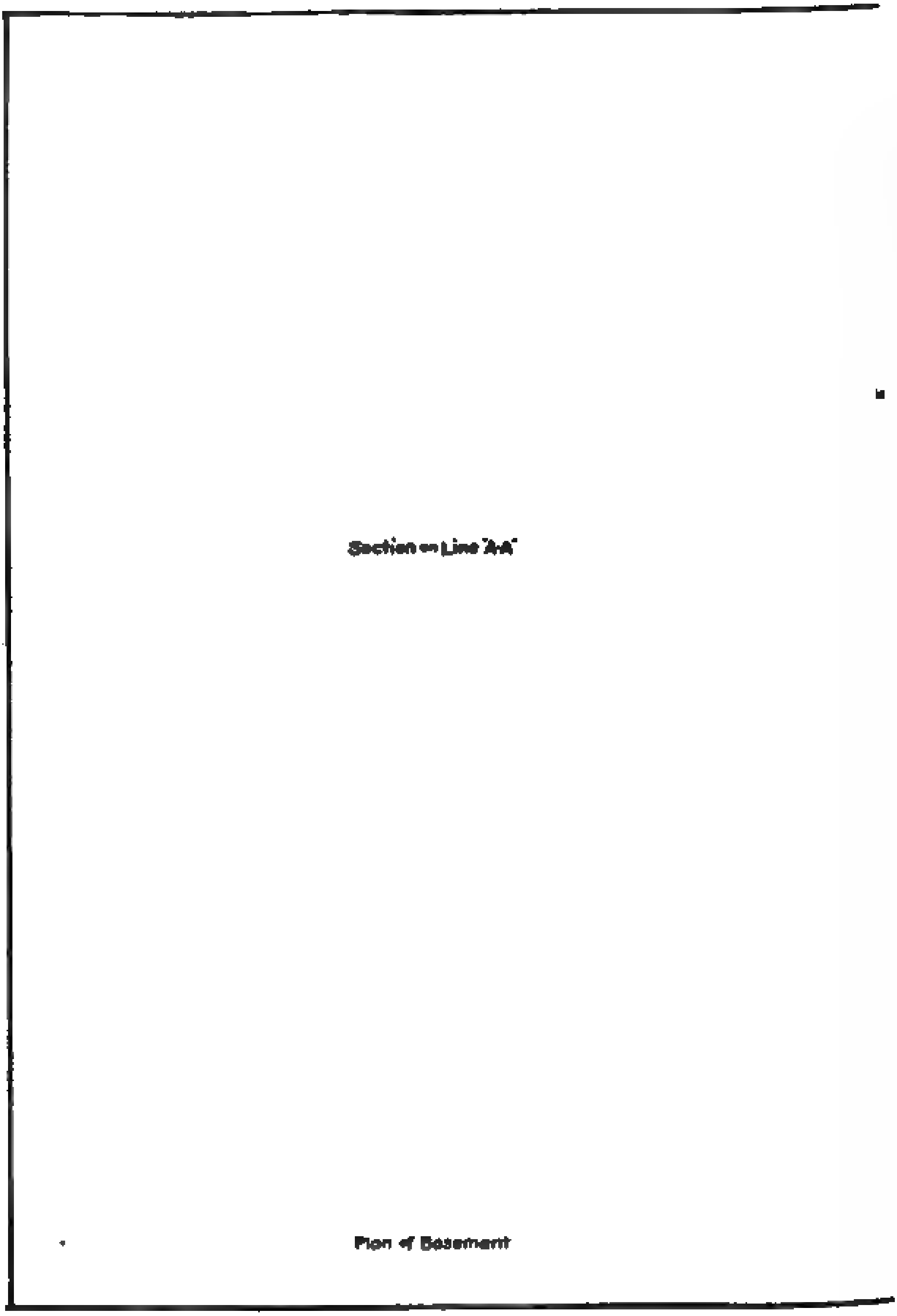


Long Distance Pumps, and Power Pumps for Barrel Filling.



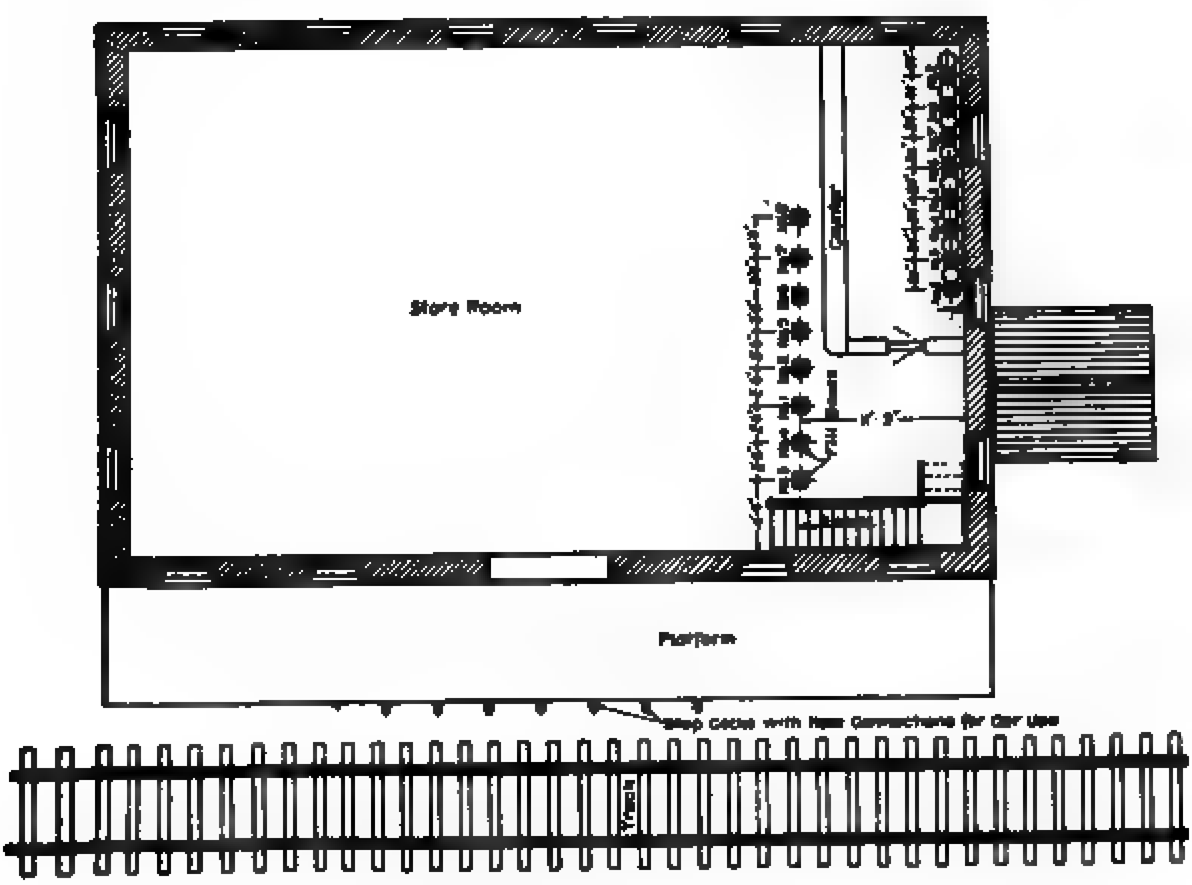
General Plan of Oil House Containing Eleven Tanks.

Gasoline and Hydro Carbon Tanks Buried Outside.



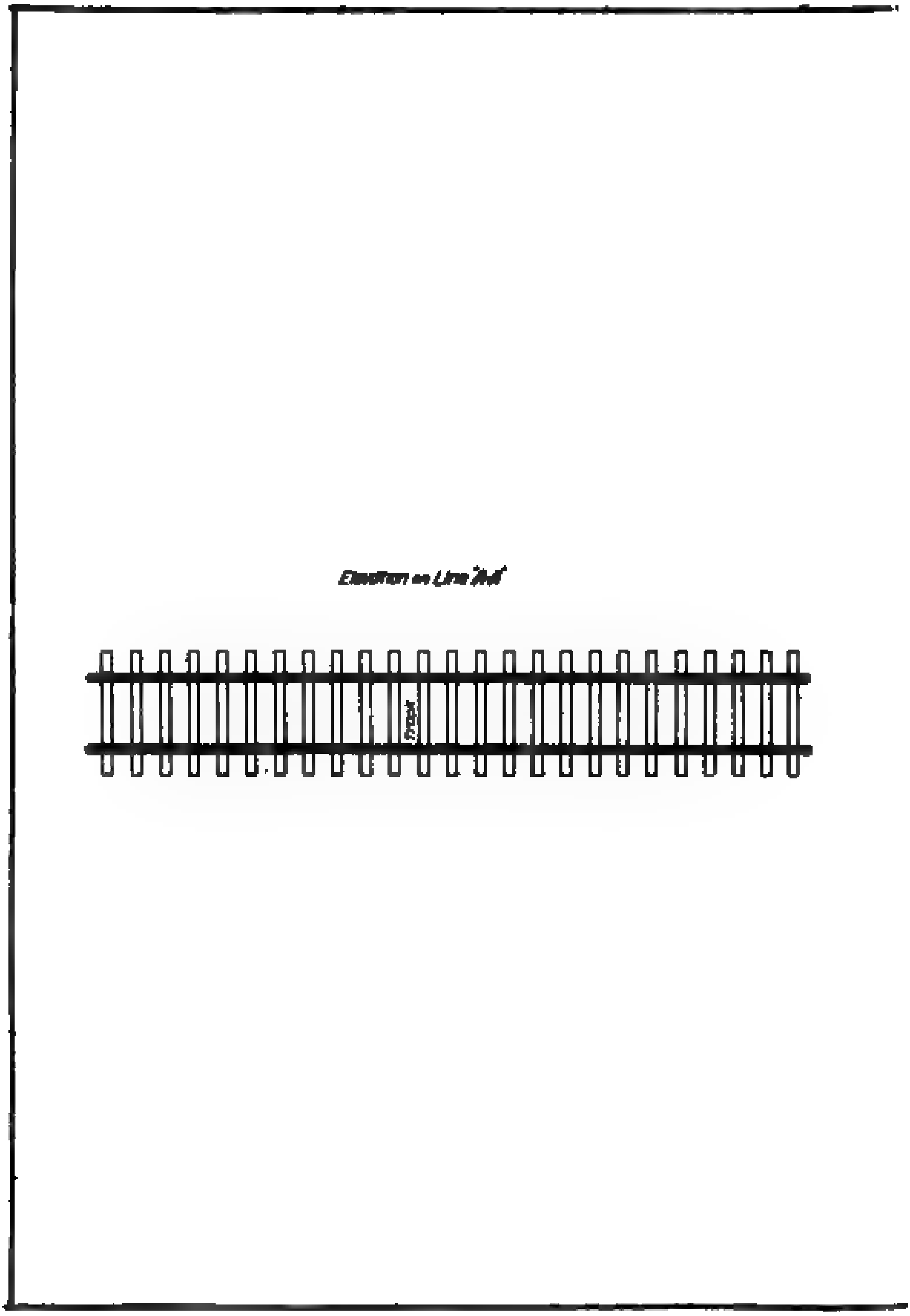
General Plan of Oil House Containing Eight Tanks.

Section on Line "B-B"

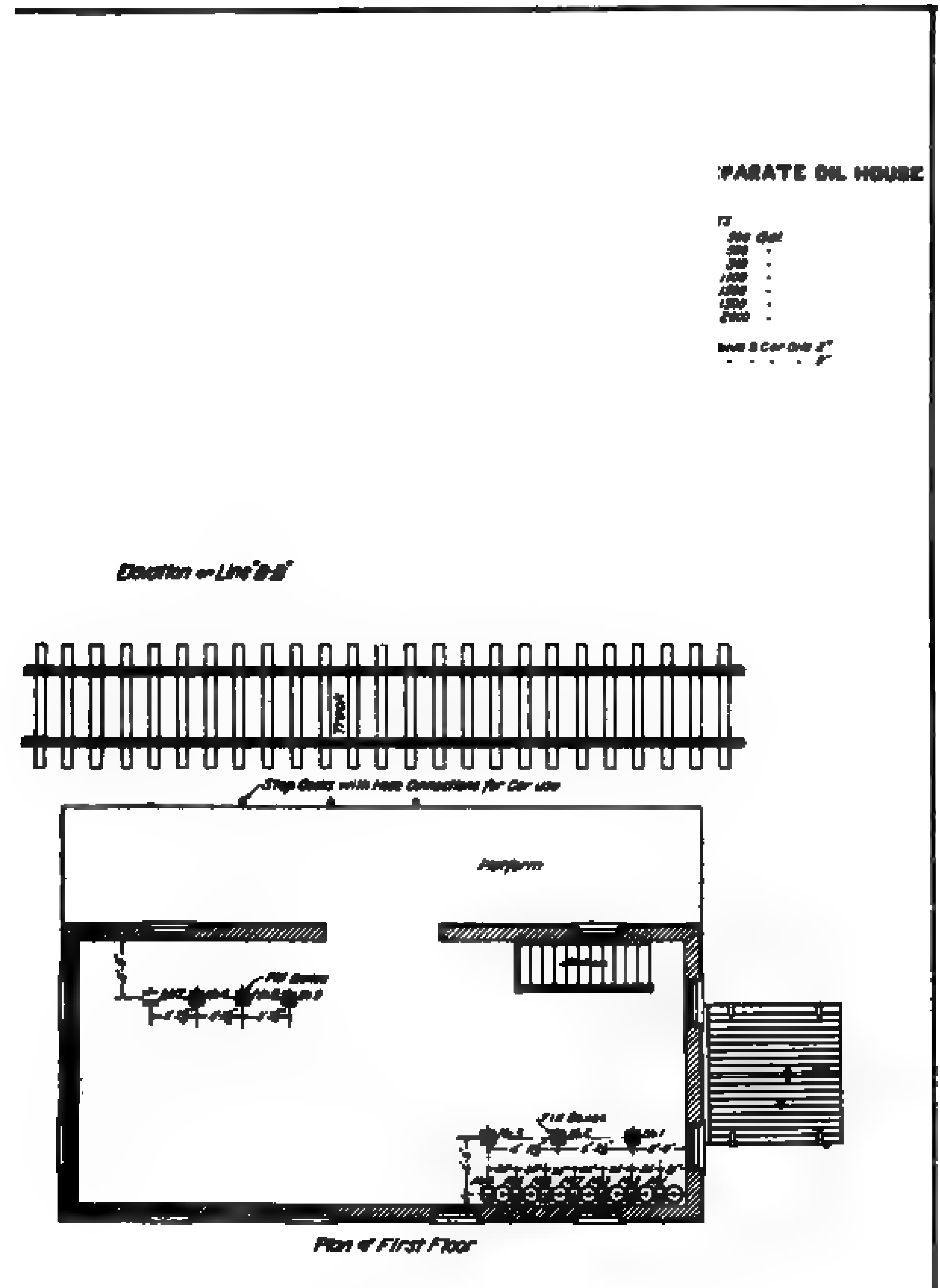


Plan of First Floor

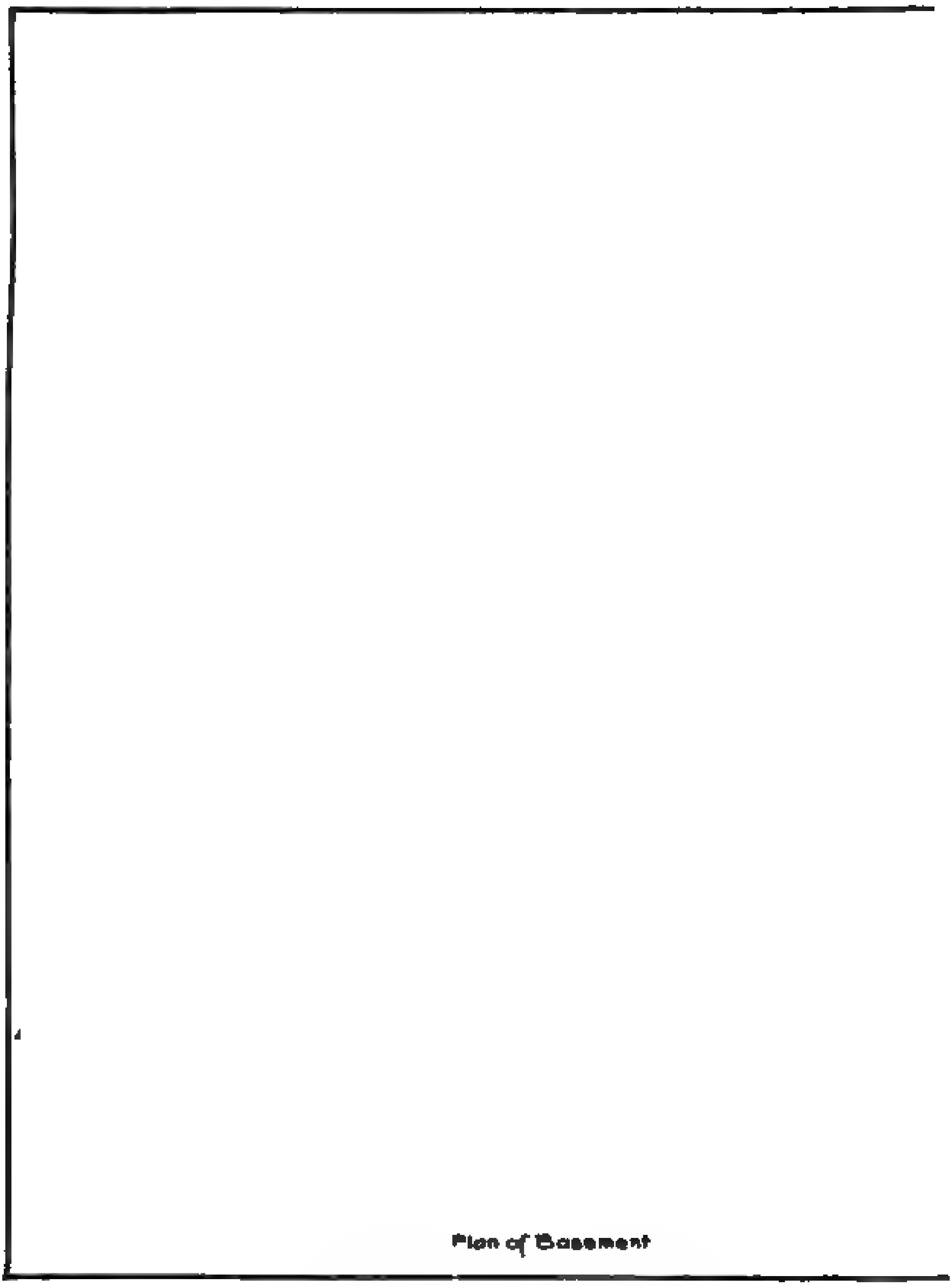
Gasoline Tank Buried Outside.



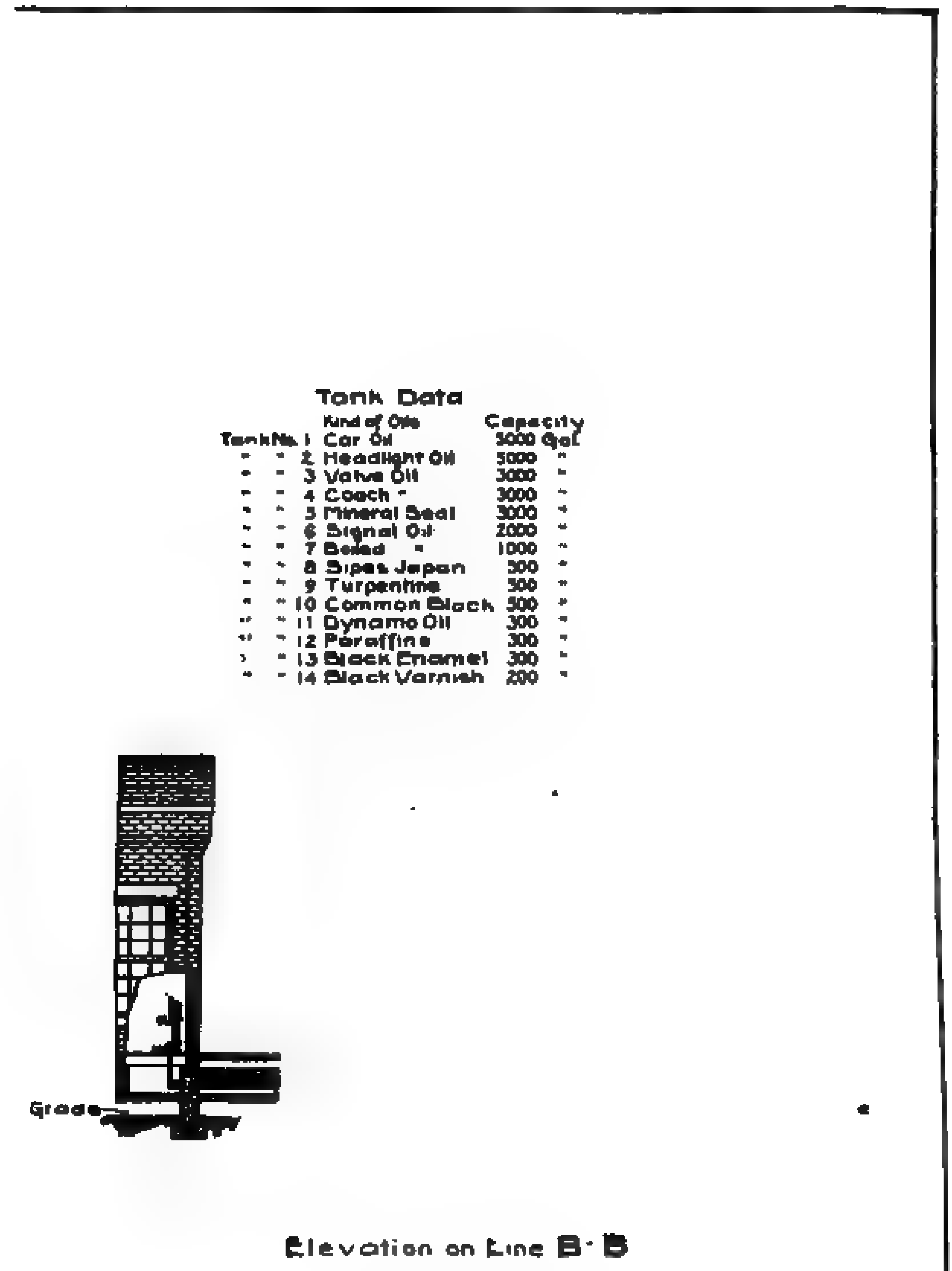
General Plan of Oil House Containing



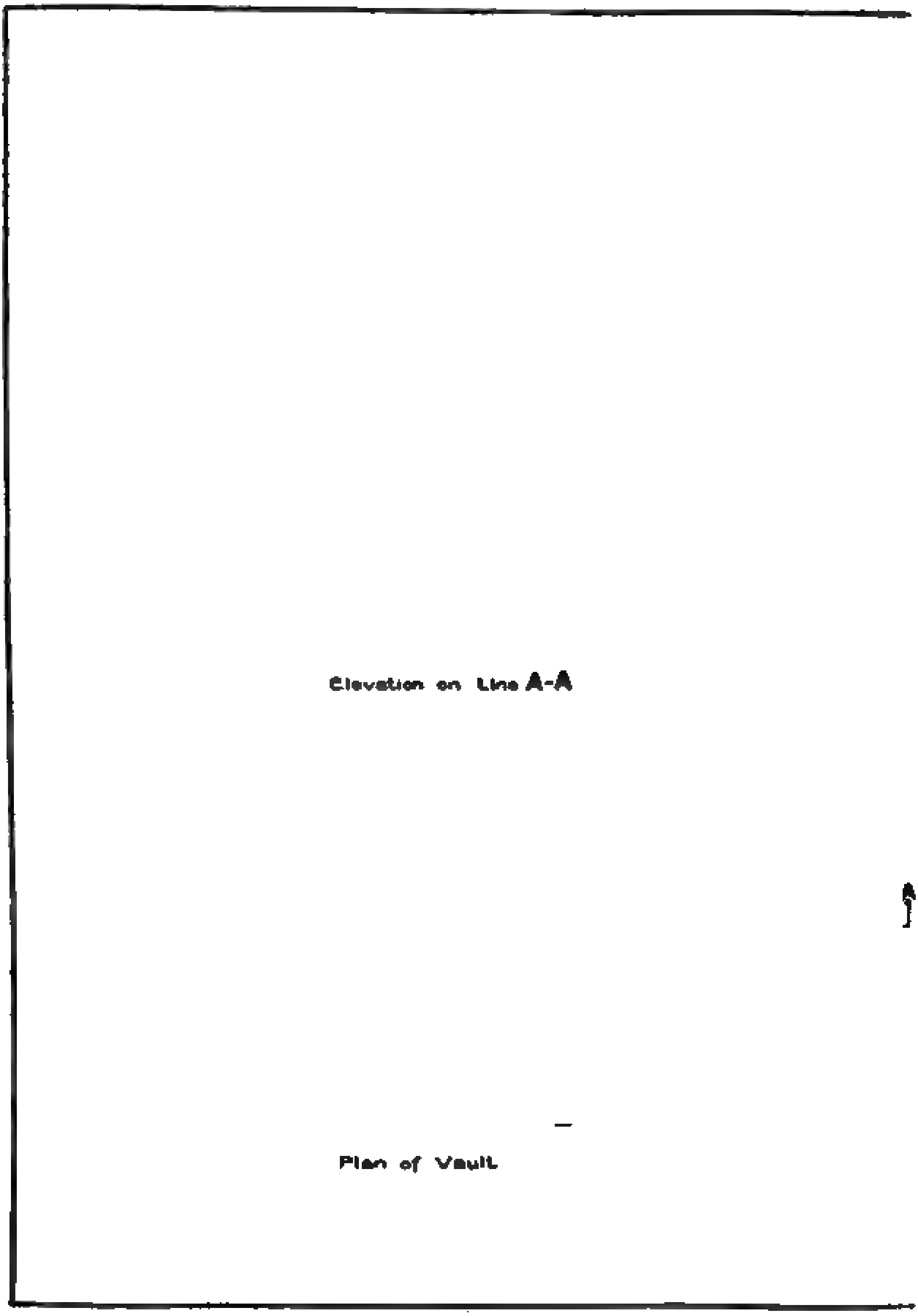
Seven Tanks in the Basement.



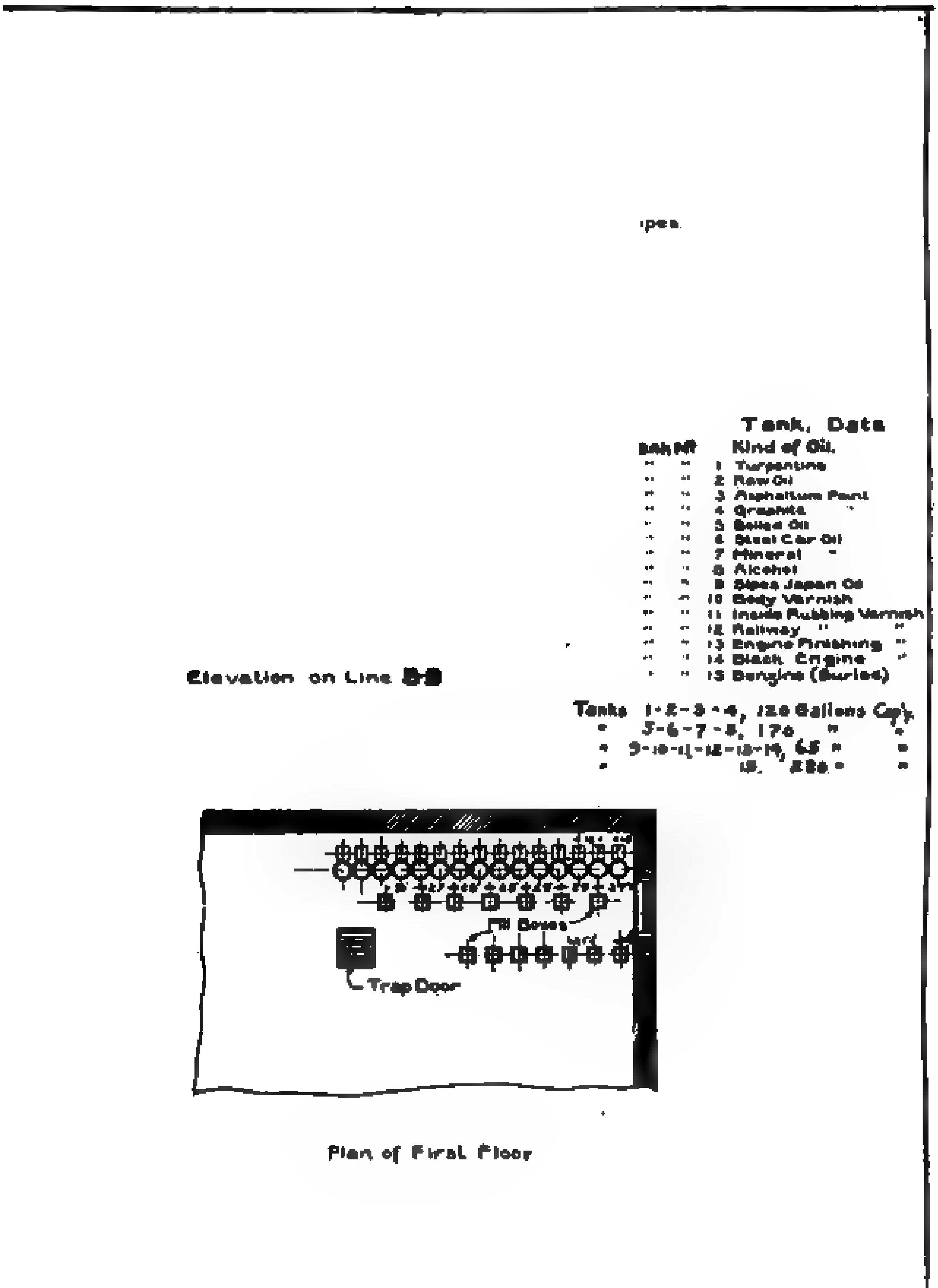
General Plan of Oil House Containing 14 Tanks Located in a Concrete Vault or Basement, 20 ft. from the Building.



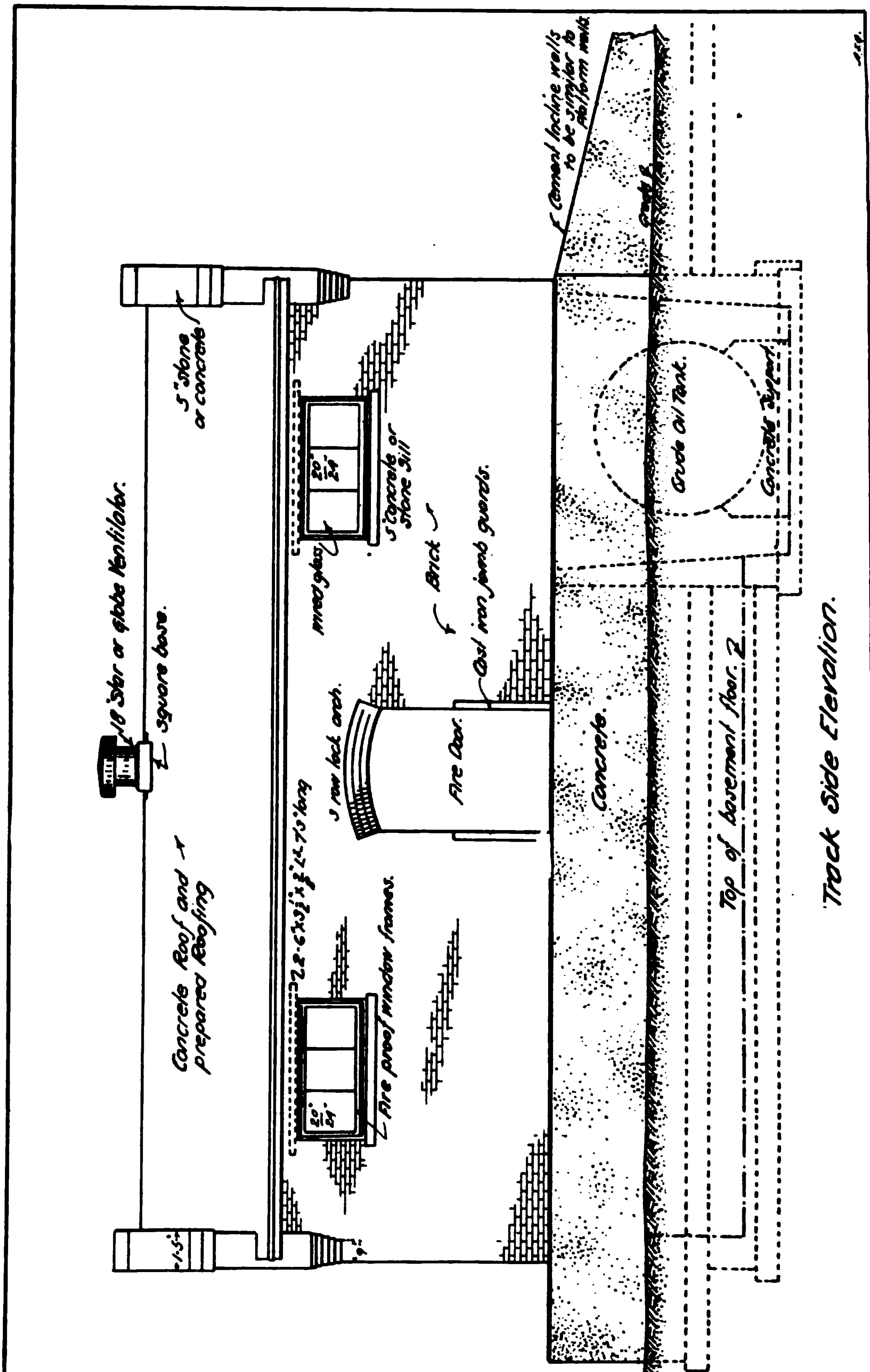
The Oil is Drawn by Means of Long Distance Pumps.



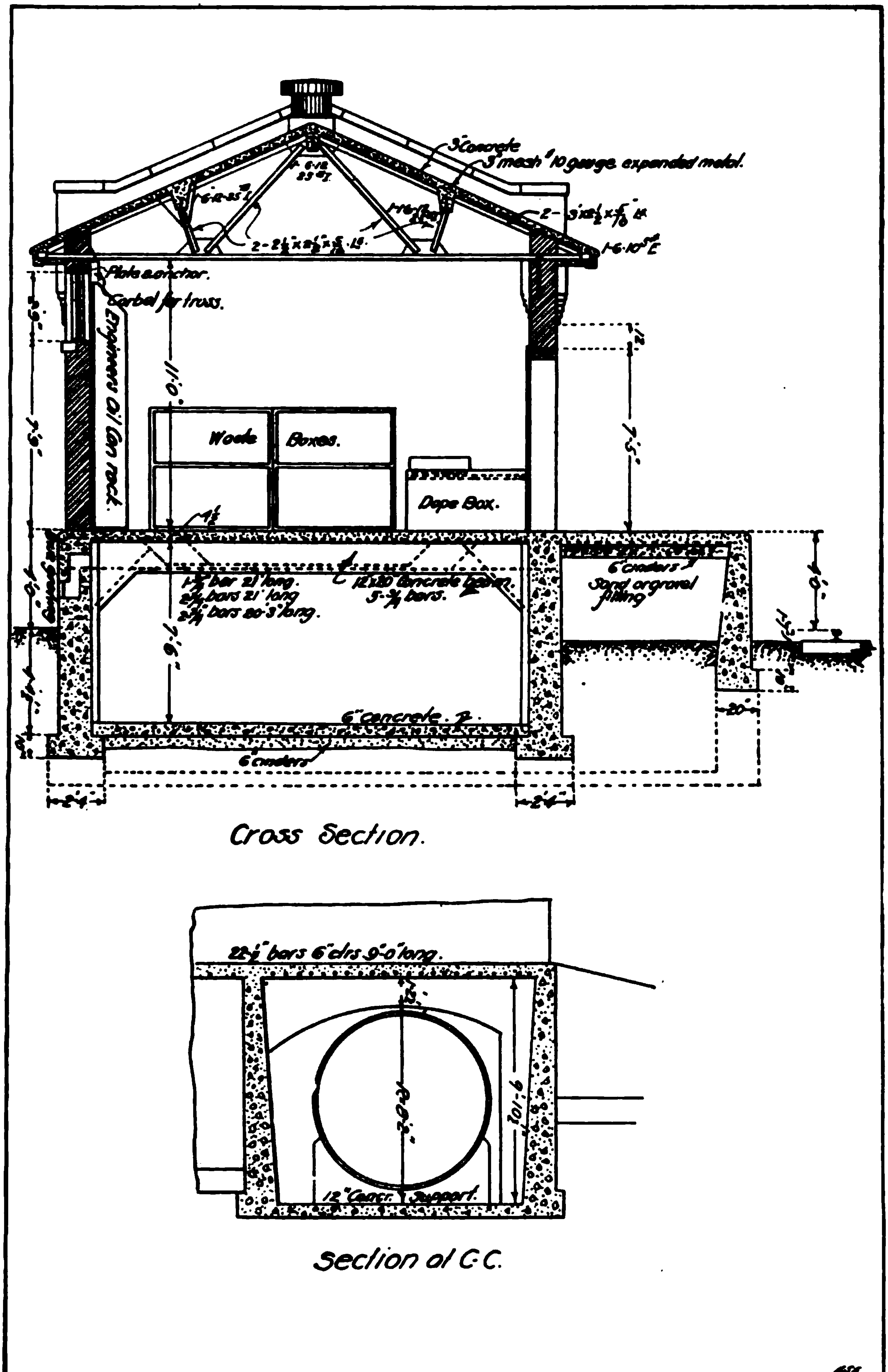
General Plan of Oil House Containing 15 Tanks, 65 to 280 Gallons Capacity.



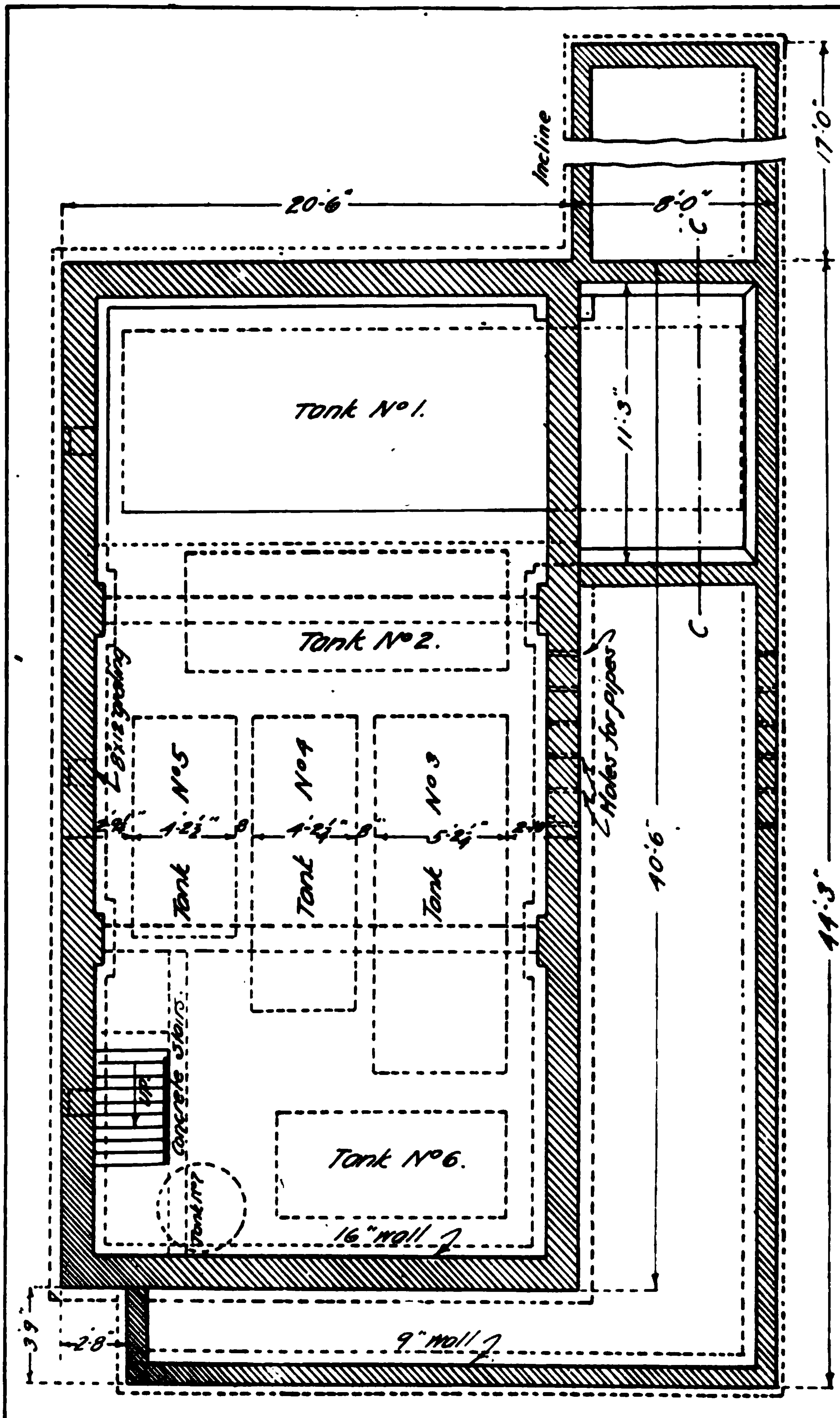
Gasoline Tank Buried Outside.



Standard No. 2 Oil House, Chicago, Rock Island & Pacific Ry.

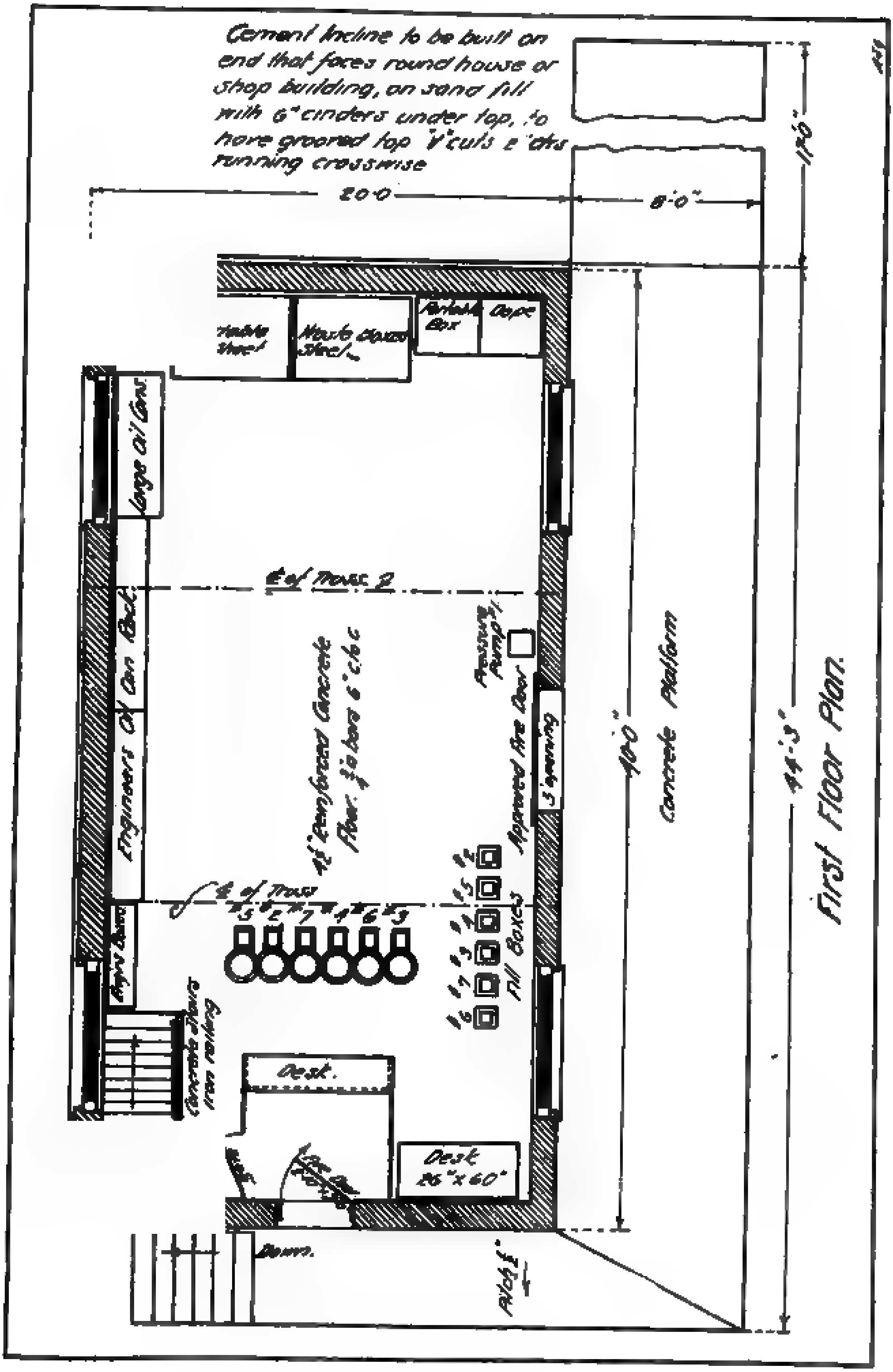


Standard No. 2 Oil House, C. R. I. & P. Ry.

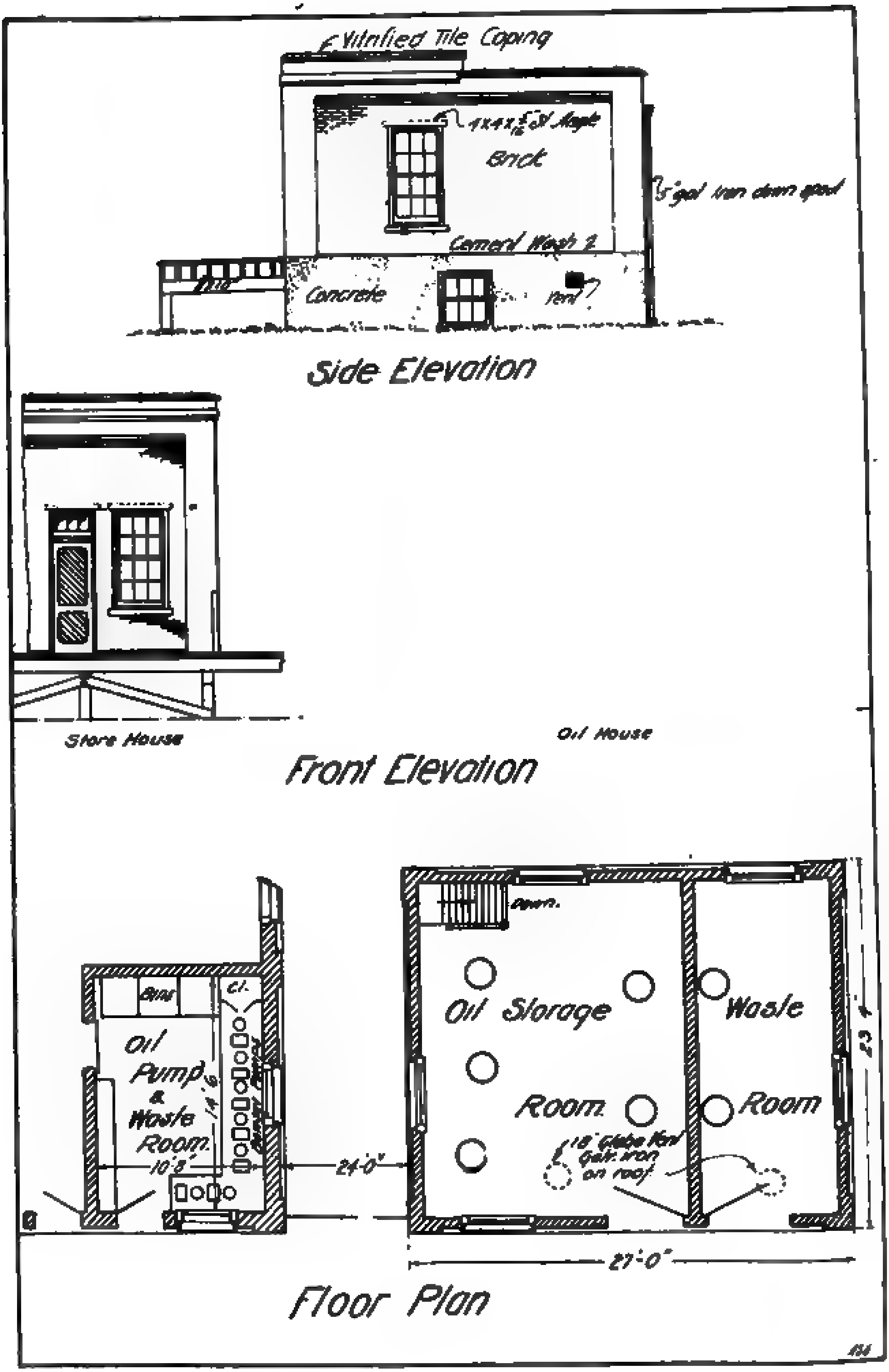


Basement and Foundation Plan.

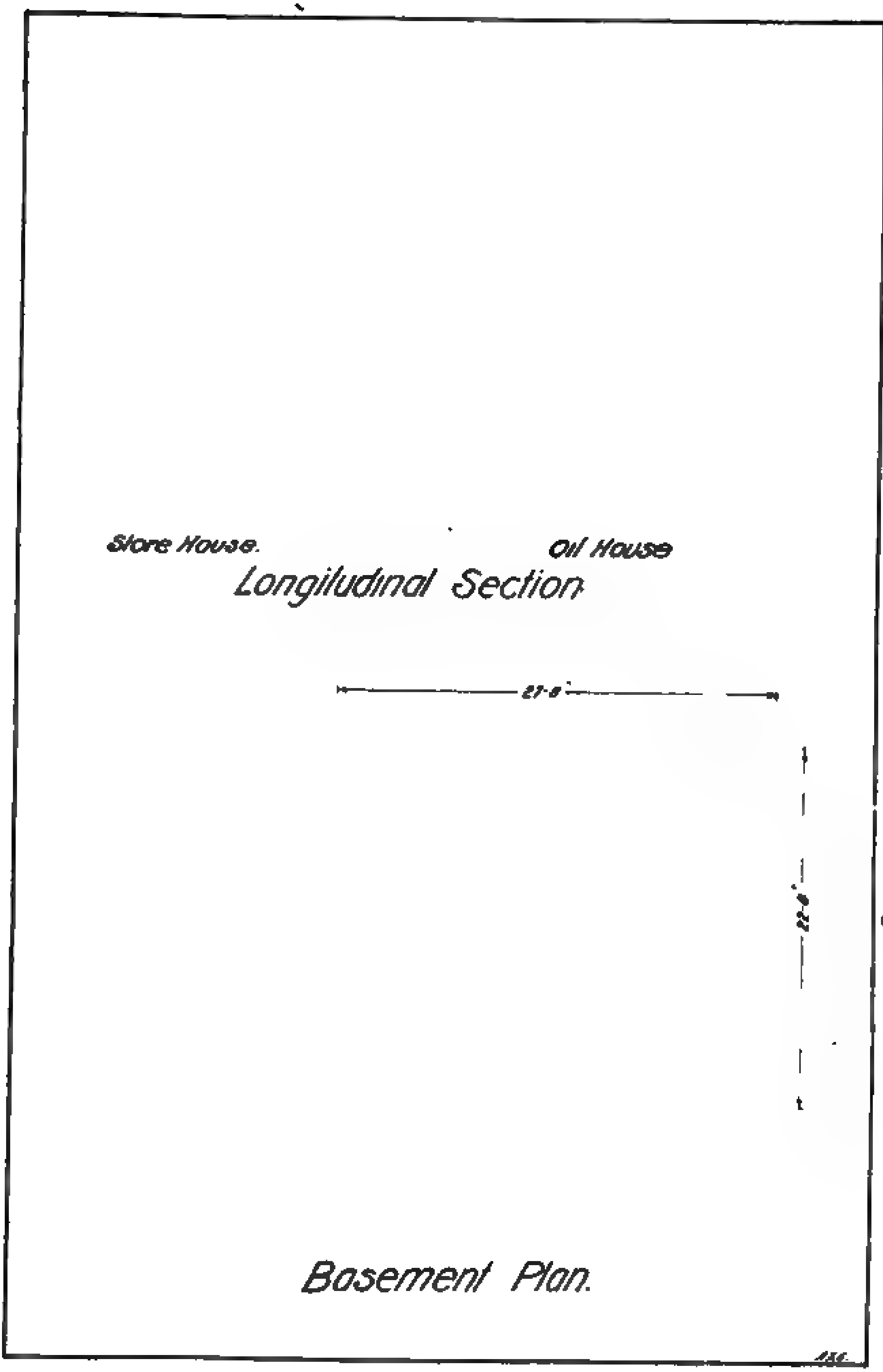
Standard No. 2 Oil House, Chicago, Rock Island & Pacific Ry.



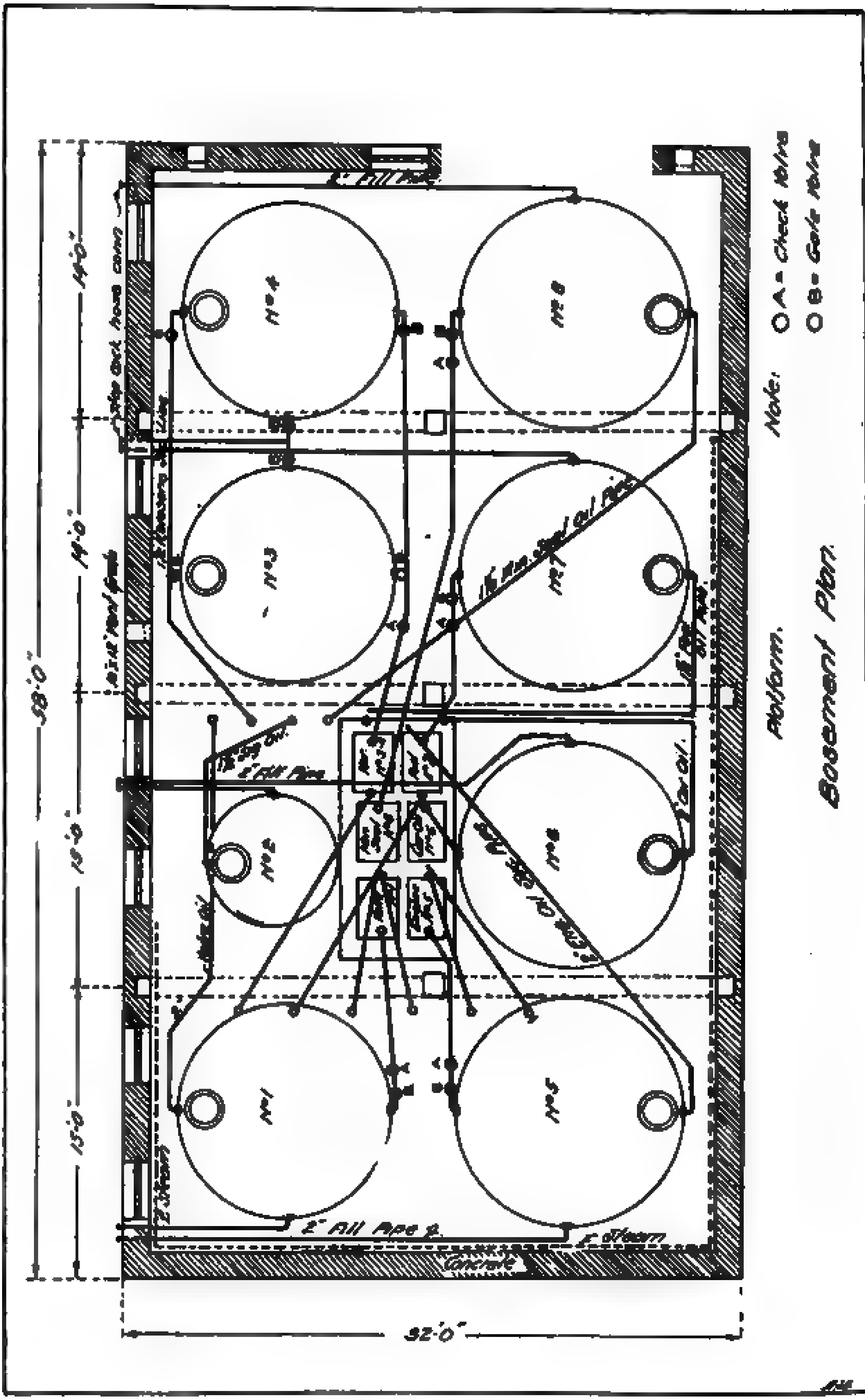
Standard No. 2 Oil House, Chicago, Rock Island & Pacific Ry.



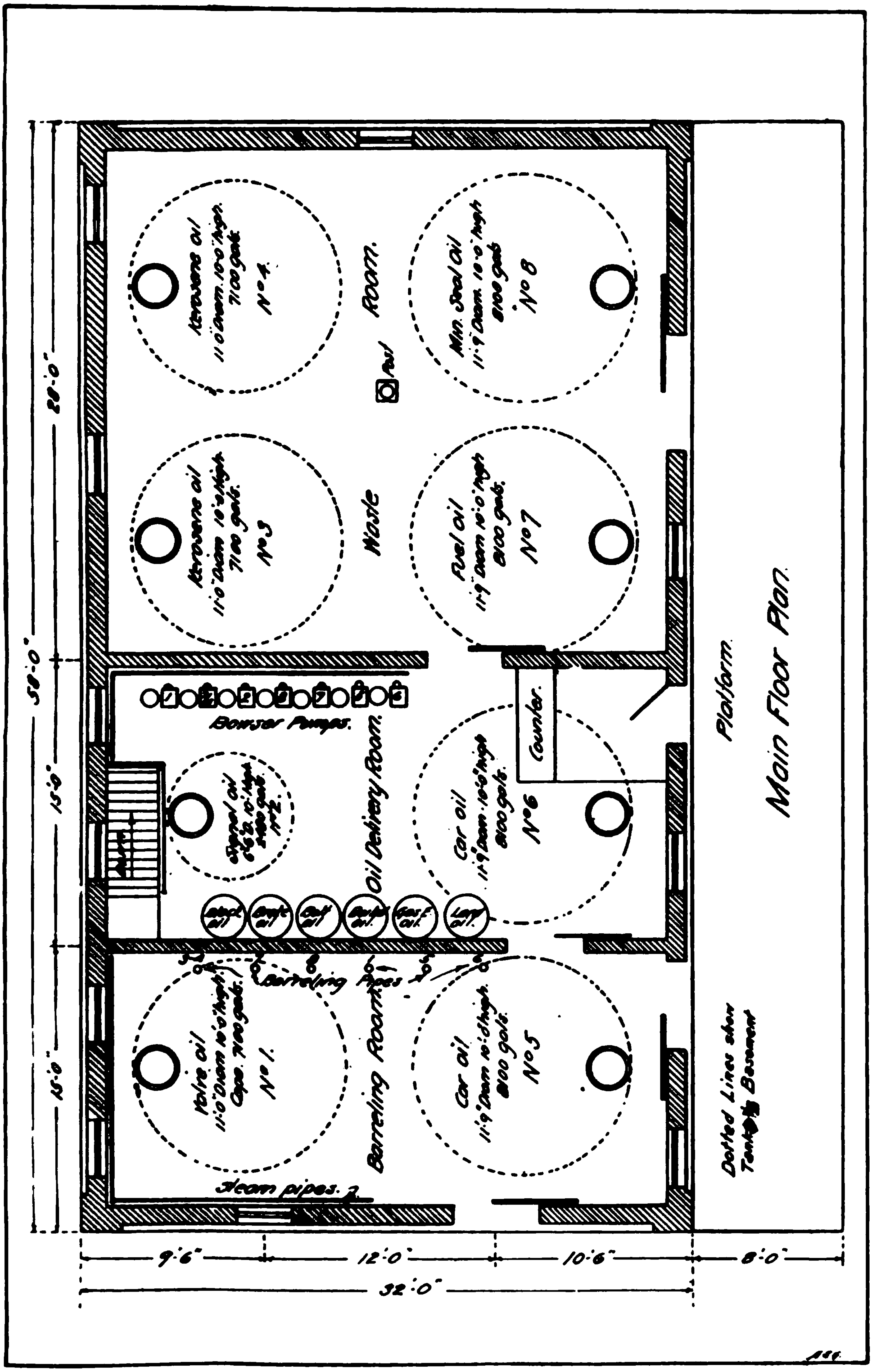
Standard Oil House, C. & N. W. Ry.



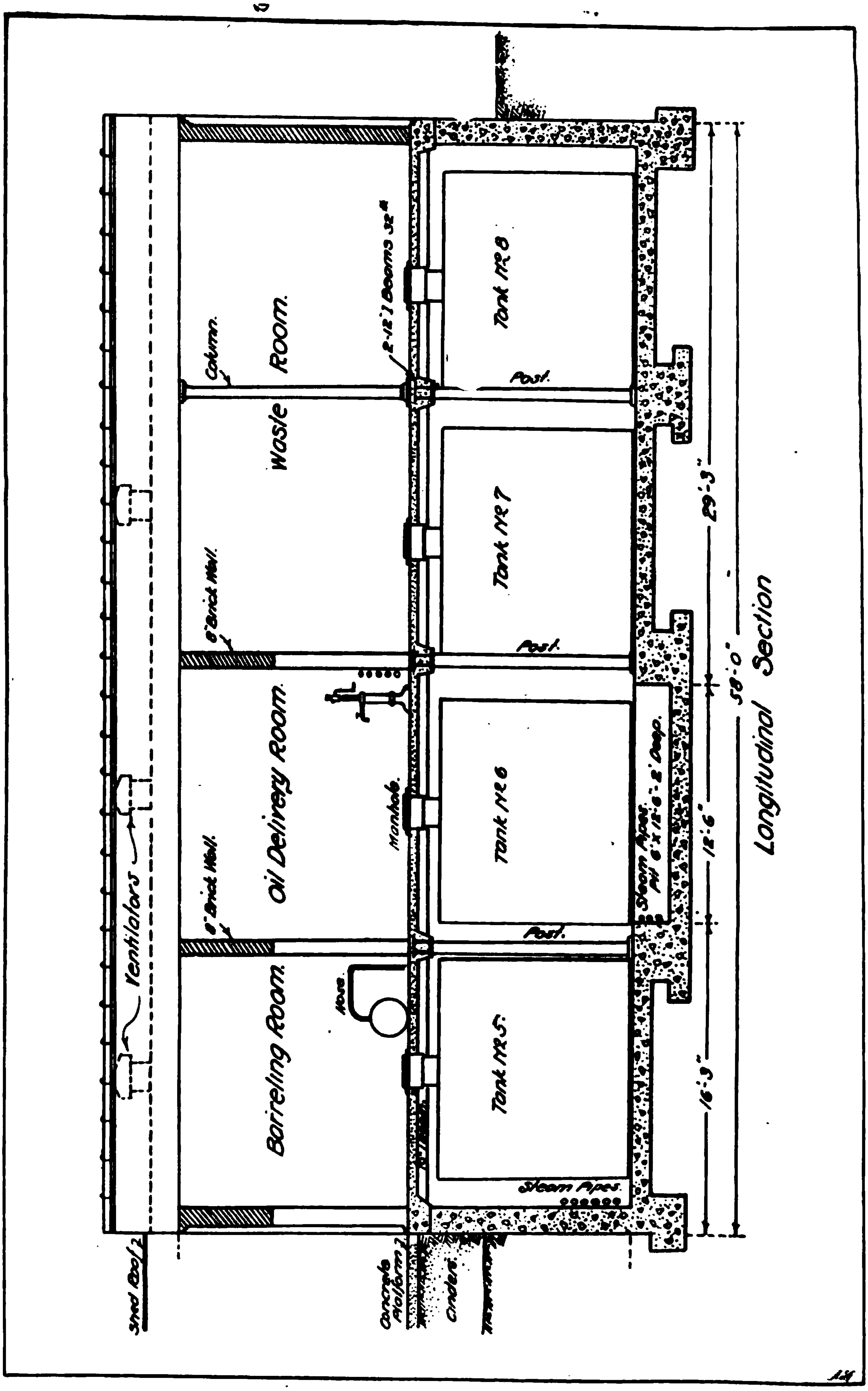
Standard Oil House, C. & N. W. Ry.



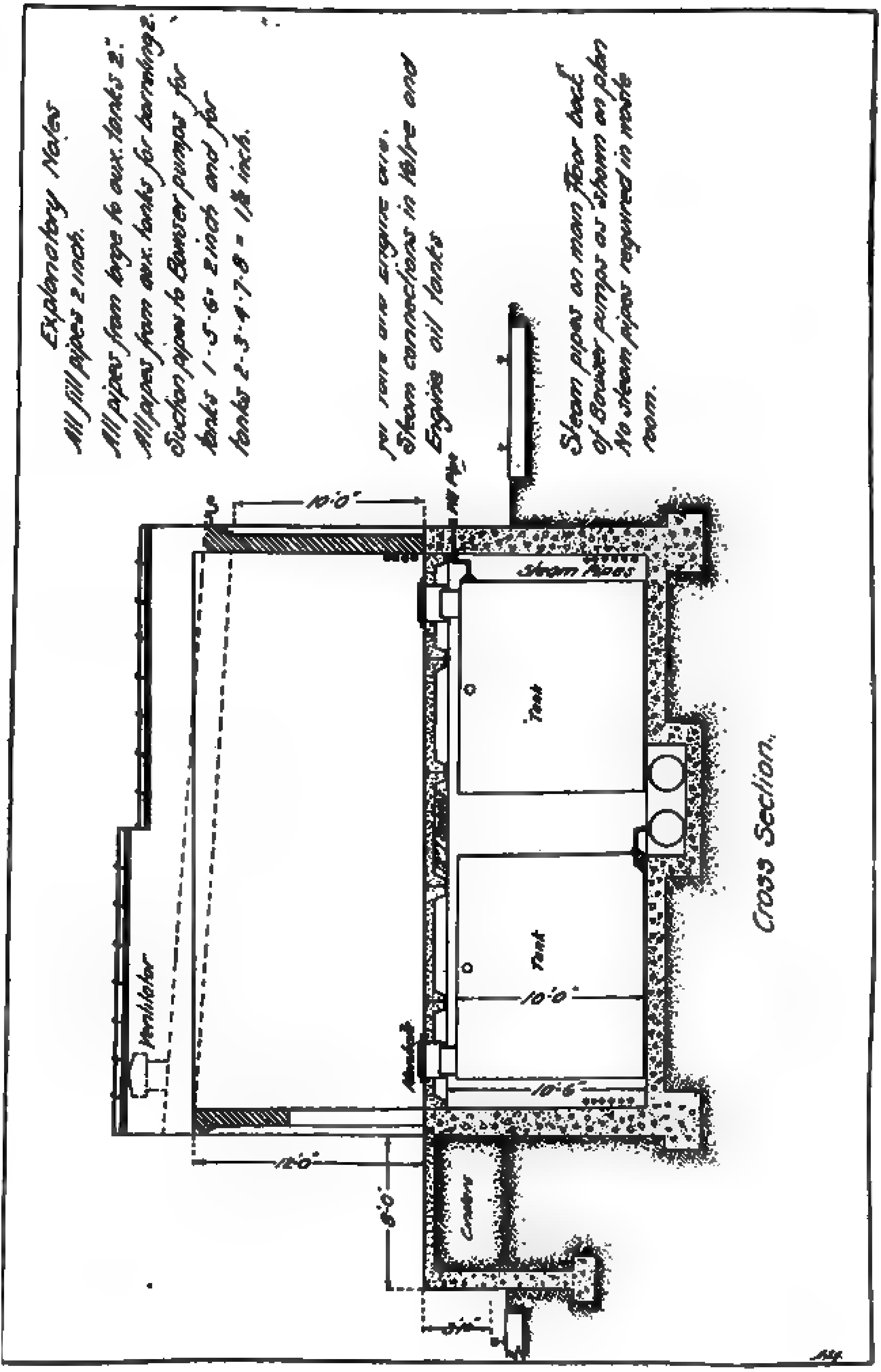
Plan for Oil House. Designed by A. M. Zimmerman.



Plan for Oil House, Designed by A. M. Zimmerman.



Plan for Oil House, Designed by A. M. Zimmerman.



Plan for Oil House, Designed by A. M. Zimmerman.

DISCUSSION.

President.—You have heard the reading of the report, what are your wishes?

Mr. Clark.—I move it be accepted. Motion seconded.

President.—The subject is open for discussion.

W. M. Clark.—Our oil houses are constructed very much on the plan as outlined in the report. They are of concrete construction throughout, concrete floor and walls, and the top is concrete-metal construction, supported on I-beams. The oil house is built at the end of the storeroom, and we have it arranged so that the delivery to storage is all done by gravity. We use compressed air to deliver our oil from the oil house to the drums.

We run a monthly oil car, and when attention is paid to it the plan is very good, but there have been times when the oil car has gone out without notification, and then some of the agents would not get their oil.

At our outlying stations we have what we call a combination coal and oil house. We have a space in the coal house for 12 tons of fuel, then we have a room in the end of this, metal-lined throughout, for the oil. Then there are some places where we do not need anything as elaborate as this, in which case we have what we call an oil cupboard. That is a metal-lined and metal-roofed box, provided with a lock, so that it can be placed outside. I do not believe in keeping oil in and about shops or freight houses.

Note: This Association received the title—American Railway Bridge and Building Association—at the 18th annual convention at Washington, D. C., October, 1908. Prior to that time it was called —Association of Railway Superintendents of Bridges and Buildings.

LIST OF ANNUAL CONVENTIONS.

No.	Place.	Date.	Membership.
1	St. Louis, Mo.,	Sept. 25, 1891.	60
2	Cincinnati, Ohio,	Oct. 18-19, 1892.	112
3	Philadelphia, Pa.,	Oct. 17-19, 1893	128
4	Kansas City, Mo.,	Oct. 16-18, 1894	115
5	New Orleans, La.,	Oct. 15-16, 1895	122
6	Chicago, Ill.,	Oct. 20-22, 1896	140
7	Denver, Col.,	Oct. 19-21, 1897	127
8	Richmond, Va.,	Oct. 18-19, 1898	148
9	Detroit, Mich.,	Oct. 17-18, 1899	148
10	St. Louis, Mo.,	Oct. 16-18, 1900	143
11	Atlanta, Ga.,	Oct. 15-17, 1901	171
12	Minneapolis, Minn.,	Oct. 21-23, 1902	195
13	Quebec, Canada,	Oct. 20-22, 1903	223
14	Chicago, Ill.,	Oct. 18-20, 1904	293
15	Pittsburg, Pa.,	Oct. 17-19, 1905	313
16	Boston, Mass.,	Oct. 16-18, 1906	340
17	Milwaukee, Wis.,	Oct. 15-17, 1907	341
18	Washington, D. C.,	Oct. 20-22, 1908	368
19	Jacksonville, Fla.,	Oct. 19-21, 1909	393
20	Denver, Colo.,	Oct. 18-20, 1910	428

	1891-2.	1892-3.	1893-4.	1894-5.
President	O. J. Travis	H. M. Hall	J. E. Wallace	Geo. W. Andrews.
First Vice-President	H. M. Hall	J. E. Wallace	Geo. W. Andrews	W. A. McGonagle.
Second Vice-President	J. B. Mitchell	G. W. Hinman	W. A. McGonagle.	L. K. Spafford.
Third Vice-President	James Stannard	N. W. Thompson	L. K. Spafford	James Stannard.
Fourth Vice-President	G. W. Hinman	C. E. Fuller	E. D. Hines	Walter G. Berg.
Secretary	C. W. Gooch	S. F. Patterson	S. F. Patterson	S. F. Patterson.
Treasurer	George M. Reid	George M. Reid	George M. Reid	George M. Reid.
Executive Members	W. R. Damon	G. W. Andrews	Q. McNab	James Stannard.
	G. W. Markley	J. M. Staten	A. S. Markley	James H. Travis.
	W. A. McGonagle	J. M. Caldwell	Floyd Ingram	J. H. Cummin.
	G. W. McGehee	Q. McNab	James Stannard	R. M. Peck.
	G. W. Turner	Floyd Ingram	James H. Travis	J. L. White.
	J. E. Wallace	A. S. Markley	J. H. Cummin	A. Shane.

	1895-6.	1896-7.	1897-8.	1898-9.
President,	W. A. McGonagle	James Stannard	Walter G. Berg	J. H. Cummin.
First Vice-President,	L. K. Spafford	Walter G. Berg	J. H. Cummin	A. S. Markley.
Second Vice-President	James Stannard	J. H. Cummin	A. S. Markley	C. C. Mallard.
Third Vice-President,	Walter G. Berg	A. S. Markley	G. W. Hinman	W. A. Rogers.
Fourth Vice-President	J. H. Cummin	R. M. Peck	C. C. Mallard	J. M. Staten.
Secretary,	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson.
Treasurer,	George M. Reid	N. W. Thompson	N. W. Thompson	N. W. Thompson.
Executive Members	R. M. Peck	W. O. Eggleston.	G. J. Bishop	Wm. S. Danes.
	J. L. White	W. M. Noon	C. P. Austin	J. H. Markley.
	A. Shane	J. M. Staten	M. Riney	W. O. Eggleston.
	A. S. Markley	G. J. Bishop	Wm. S. Danes	R. L. Heflin.
	W. M. Noon	C. P. Austin	J. H. Markley	F. W. Tanner.
	J. M. Staten	M. Riney	W. O. Eggleston	A. Zimmerman.

	1899-1900.	1900-1901.	1901-1902.	1902-1903.
President,	Aaron S. Markley	W. A. Rogers	W. S. Danes	B. F. Pickering.
First Vice-President,	W. A. Rogers	W. S. Danes	B. F. Pickering	C. C. Mallard.
Second Vice-President	J. M. Staten	B. F. Pickering	A. Shane	A. Shane.
Third Vice-President,	Wm. S. Danes	A. Shane	A. Zimmerman	A. Zimmerman.
Fourth Vice-President	B. F. Pickering	A. Zimmerman	C. C. Mallard	A. Montzheimer.
Secretary,	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson.
Treasurer,	N. W. Thompson	N. W. Thompson	N. W. Thompson	N. W. Thompson.
Executive Members	T. M. Strain	T. M. Strain	A. Montzheimer	W. E. Smith.
	R. L. Heflin	H. D. Cleaveland	W. E. Smith	A. W. Merrick.
	F. W. Tanner	F. W. Tanner	A. W. Merrick	C. P. Austin.
	A. Zimmerman	A. Montzheimer	C. P. Austin	C. A. Lichty.
	H. D. Cleaveland	W. E. Smith	C. A. Lichty	W. O. Eggleston.
	A. Montzheimer.	A. W. Merrick	W. O. Eggleston	J. H. Markley.

	1903-1904.	1904-1905.	1905-1906.	1906-1907.
President,	A. Montzheimer	C. A. Lichty	J. B. Sheldon	J. H. Markley.
First Vice-President,	A. Shane	J. B. Sheldon	J. H. Markley	R. H. Reid.
Second Vice-President	C. A. Lichty	J. H. Markley	R. H. Reid	J. P. Canty.
Third Vice-President,	J. B. Sheldon	R. H. Reid	R. C. Sattley	H. Rettinghouse.
Fourth Vice-President	J. H. Markley	R. C. Sattley	J. P. Canty	F. E. Schall.
Secretary,	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson.
Treasurer,	C. P. Austin	C. P. Austin	C. P. Austin	C. P. Austin.
Executive Members	R. H. Reid	W. O. Eggleston	H. Rettinghouse	W. O. Eggleston.
	W. O. Eggleston	A. E. Killam	A. E. Killam	A. E. Killam.
	A. E. Killam	H. Rettinghouse	J. S. Lemond	J. S. Lemond.
	R. C. Sattley	J. S. Lemond	C. W. Richey	C. W. Richey.
	H. Rettinghouse	W. H. Finley	H. H. Eggleston	H. H. Eggleston.
	J. S. Lemond	C. W. Richey	F. E. Schall	B. J. Sweatt.

	1907-1908.	1908-1909.	1909-1910.	1910-1911.
President, ...	R. H. Reid......	J. P. Canty	J. S. Lemond.....	H. Rettinghouse...
First Vice-President, ...	J. P. Canty.....	H. Rettinghouse..	H. Rettinghouse...	F. E. Schall......
Second Vice-President...	H. Rettinghouse..	F. E. Schall.....	F. E. Schall......	A. E. Killam......
Third Vice-President, ..	F. E. Schall	J. S. Lemond....	A. E. Killam.....	J. N. Penwell....
Fourth Vice-President...	W. O. Eggleston.	A. E. Killam....	J. N. Penwell....	T. L. D. Hadwen..
Secretary, ...	S. F. Patterson..	S. F. Patterson..	C. A. Lichty......	C. A. Lichty.......
Treasurer, ...	C. P. Austin....	C. P. Austin....	J. P. Canty......	J. P. Canty.......
Executive Members..	A. E. Killam....	J. N. Penwell....	W. Beahan	T. J. Fullem.......
	J. S Lemond.....	Willard Beahan ..	F. B. Scheetz ...	G. Aldrich........
	C. W. Richey....	F. B. Scheetz...	T. L. D. Hadwen..	P. Swenson.......
	T. S. Leake......	W. H. Finley...	T. J. Fullem......	G. W. Rear.......
	W. H. Finley....	T. L. D. Hadwen	G. Aldrich........	W. O. Eggleston..
	J. N. Penwell....	T. J. Fullem....	P. Swenson.......	W. F. Steffens....

CONSTITUTION

ARTICLE I.

NAME.

SECTION 1. This association shall be known as the American Railway Bridge & Building Association.

ARTICLE II.

OBJECT.

SECTION 1. The object of this association shall be the advancement of knowledge pertaining to the principles, design, construction and maintenance of railway bridges, buildings and other structures, by investigation, reports and discussion of the experience of its members and others, and to provide a means of exchange of ideas, so that bridge and building practice may be systematized and improved.

SECT. 2. The association shall neither endorse nor recommend any particular patents, materials or supplies, but individual opinions of members may be expressed and appear in the proceedings.

ARTICLE III.

MEMBERSHIP.

SECTION 1. The membership of this association shall consist of two classes, active and life members.

SECT. 2. A person who is actively engaged in railway service in a responsible position, in charge of work connected with the construction or maintenance of railway bridges and buildings or other structures, or a professor of engineering, government timber expert, or railroad architect shall be eligible for active membership upon application to the secretary, and the payment of three dollars membership fee, and two dollars for one year's dues.

SECT. 3. Any member elected a life member of this association shall have all the privileges of an active member, but shall not be required to pay annual dues. To be elected a life member he must have been a member of the association at least five years and before being elected must have been pensioned by the railway company for which he worked or shall have retired from active railway service.

SECT. 4. Any member guilty of dishonorable conduct, or conduct unbecoming a railroad official and member of this association, or who shall refuse to obey the chairman, or rules, may be expelled by a two-thirds vote of the members present.

SECT. 5. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled.

ARTICLE IV.

OFFICERS.

SECTION 1. The officers of this association shall be a president, four vice-presidents, a secretary, a treasurer, and six executive members.

SECT. 2. The executive members, together with the president, vice-presidents, secretary and treasurer, shall constitute the executive committee.

SECT. 3. Past presidents of this association who continue to be members shall be entitled to be present at all meetings of the executive committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past-presidents shall not have a right to vote, nor shall their presence be requisite in order to constitute a quorum.

SECT. 4. Vacancies in any office for the unexpired term shall be filled by the executive committee without unnecessary delay.

ARTICLE V.

EXECUTIVE COMMITTEE.

SECTION 1. The executive committee shall exercise a general supervision over the financial interests of the association, assess the amount of annual and other dues, call, prepare for and conduct general or special meetings, make all necessary purchases and contracts required to conduct the general business of the association, but shall not have the power to render the association liable for any debt beyond the amount then in the treasurer's hands not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the association.

SECT. 2. Two thirds of the members of the executive committee may call special meetings, thirty days' notice being given members by mail.

SECT. 3. Five members of the executive committee shall constitute a quorum for the transaction of business.

ARTICLE VI.

ELECTION OF OFFICERS AND TENURE OF OFFICE.

SECTION 1. The officers, excepting as otherwise provided, shall be elected at the regular meeting of the association, held on the third Tuesday in October of each year, and the election shall not be postponed except by unanimous consent.

SECT. 2. The president and treasurer shall be elected by ballot or by a majority of votes cast, and shall hold office for one year or until successors are elected. No member in arrears shall be eligible for office, and the president shall not be eligible for re-election.

Vice-Presidents and Executive Members.

SECT. 3. The vice-presidents shall hold office for one year and executive members for two years; four vice-presidents and three executive members to be elected each year; all officers herein named to hold office until successors are chosen.

SECT. 4. In the election of vice-presidents, each one shall be elected by a majority vote. Executive members shall be elected in the same way, all voting to be by written ballots.

Secretary.

SECT. 5. A secretary shall be elected by a majority of the votes of the members present at the annual meeting. The term of office of the secretary shall be for one year, unless terminated sooner by action of the executive committee, two thirds of whom may remove the secretary at any time. His compensation shall be fixed by a majority of the executive committee. The secretary shall also be secretary of the executive committee.

Treasurer.

SECT. 6. The treasurer shall be required to give bond in an amount to be fixed by the majority of the executive committee.

ARTICLE VII.

COMMITTEES.

Nominating Committee.

SECTION 1. After each annual meeting the president shall appoint a committee of five members, not officers of the association, of whom two at least shall be past presidents, and two of whom shall have served on the committee the previous year. They shall prepare a list of names of nominees for officers to be voted on at the next annual convention, agreeable to Article VI. of this constitution, said list to be read at the first session of the second day of said convention. Nothing in this section shall be construed to prevent any member making nominations.

Auditing Committee.

SECT. 2. At the first session of each annual meeting there shall be appointed by the president an auditing committee of three members, not officers of the association, whose duty it shall be to examine the accounts and vouchers of the secretary and treasurer and certify as to the correctness of their accounts. Acceptance of this committee's report will be regarded as the discharge of the committee.

Committee on Subjects for Discussion.

SECT. 3. At the annual meeting there shall be appointed, by the president, a committee, whose duty it shall be to prepare and report subjects for investigation and discussion at the next annual meeting. It shall be the duty of the committee to receive from members questions for discussion during the time set apart for that purpose. This committee shall decide whether such questions are suitable ones for discussion, and if approved, report them to the association.

Committees on Investigation.

SECT. 4. When the committee on subjects has reported and the association approved of the same, the president shall appoint special committees to investigate and report on said subjects and he may appoint a special committee to investigate and report on any subject of which a majority of members present may approve.

Publication Committee.

SECT. 5. After each annual meeting the executive committee shall appoint a publication committee of three active members whose duty it shall be to supervise the publication of the proceedings. The assignment of this committee shall be such that at least one member shall have served on the committee during the previous year. The publication committee will report to the president and perform their duties under his supervision.

ARTICLE VIII.

ANNUAL DUES.

SECTION 1. Every active member shall pay to the secretary three dollars membership fee and shall also pay two dollars per year in advance to defray the necessary expenses of the association. No member being one year in arrears for dues shall be entitled to vote at any election, and any member one year in arrears may be stricken from the list of members at the discretion of the executive committee.

ARTICLE IX.

AMENDMENTS.

SECTION 1. This constitution may be amended at any regular meeting by a two thirds vote of members present, provided that a written notice of the proposed amendment, or amendments, has been given at least sixty days previous to said regular meeting.

BY-LAWS

TIME OF MEETING.

1. The regular meeting of this association shall be held annually on the third Tuesday in October.

HOUR OF MEETING.

2. The regular hour of meeting shall be at 10 o'clock a. m., unless changed by order of the presiding officer.

PLACE OF MEETING.

3. The cities or places for holding the annual convention may be proposed at any regular meeting of the association before the final adjournment. The places proposed shall be submitted to a ballot vote of the members of the association, the city or place receiving a majority of all the votes cast to be declared the place of the next annual meeting; but if no place received a majority of all votes, then the place receiving the lowest number of votes shall be dropped on each subsequent ballot until a place is chosen.

QUORUM.

4. At the regular meeting of the association, fifteen or more members shall constitute a quorum.

ORDER OF BUSINESS.

5. 1st—Calling of roll.
   2nd—Reading minutes of last meeting.
   3rd—Admission of new members.
   4th—President's address.
   5th—Reports of secretary and treasurer.
   6th—Payment of annual dues.
   7th—Appointment of committees.
   8th—Reports of committees.
   9th—Unfinished business.
   10th—New business.
   11th—Reading and discussion of questions propounded by members.
   12th—Miscellaneous business.
   13th—Election of officers.
   14th—Adjournment.

(Report of nominating committee to be read at first session of second day.)

DUTIES OF OFFICERS.

6. The president shall have general supervision of the affairs of the association. He shall preside at all meetings of the association, and of the executive committee, at which he may be present; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. He shall, with the secretary, sign all contracts or other written obligations of the association which have been approved by the executive committee.

At the annual meeting the president shall present a report containing a statement of the general condition of the association, and an address.

7. The vice-presidents in order of seniority shall preside at meetings in the absence of the president, and discharge his duties in case of a vacancy in his office.

8. It shall be the duty of the secretary to keep a correct record of proceedings of all meetings of this association; to keep correct all accounts between this association and its members; collect all moneys due the association, and pay the same over to the treasurer and take his receipt therefor, and to perform such other duties as the association may require.

9. The treasurer shall receive all moneys and deposit the same in the name of the association and shall receipt to the secretary therefor. He shall invest all funds not needed for current disbursements as shall be ordered by the executive committee. He shall pay all bills, when properly certified and approved by the president, and make such reports as may be called for by the executive committee.

DECISIONS.

10. The votes of a majority of members present shall decide any question, motion or resolution which shall be brought before the association, unless otherwise provided.

DISCUSSIONS.

11. All discussions shall be governed by Robert's rules of order.

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Patterson, S. F., Gen'l For. B. and B., B. & M. R. R., Concord, N. H.
Pauba, A. W., For. B. and B., C. & S. Ry., Denver, Colo.
Peabody, Kemper, Gen'l For. Buildings, N. Y. C. & H. R. R. R., New York City.
Penwell, J. N., Supvr. B. and B., L. E. & W. Ry., Tipton, Ind.
Perkins, H. D., 5725 Franklin Ave., Cleveland, Ohio.
Perry, W. W., Mast. Carp., P. & R. Ry., Williamsport, Pa.
Pettis, W. A., Gen'l Supvr. of Buildings, N. Y. C. & H. R. R. R., Rochester, N. Y.
Phillips, Henry W., N. Y. N. H. & H. R. R., So. Braintree, Mass.
Phillips, B. P., Asst. Supvr. B. and B., N. Y. N. H. & H. R. R., Williamantic. Conn.
Pickens, J. E., Engr. & Contr., Kankakee, Ill.
Pickering, B. F., Gen'l For. B. and B., B. & M. R. R., Salem, Mass.
Pollard, H. Asst. Gen'l Br. Insp., S. P. Co., San Francisco, Cal.
Pollock, H. H., Mast. Carp. of Bldgs., P. C. C. & St. L. Ry., Carnegie, Pa.
Porter, L. H., Box 35, Andover, Conn.
Powell, C. E., Supt. B. and B., C. & O. Ry., Hinton, W. Va.
Powell, W. T., Supt. B. and B., C. & S. Ry., Denver, Col.
Powers, G. F., Contractor, Joliet, Ill.
Proctor, V. C., Gen'l For. B. and B., A. T. & S. F. Ry., Winslow, Ariz.

Quinn, William, Mast. Carp., St. L. S. W. Ry., of T., Tyler, Tex.

Rand, F. C., Gen'l For. B. and B., B. & M. R. R., Boston.
Rear, G. W., Gen'l Insp., S. P. Co., San Francisco, Cal.
Redfield, J. A. S., Res. Engr., C. & N. W. Ry., Hawarden, Ia.
Reed, William, Timber Insp., I. C. R. R., Grenada, Miss.
Reid, R. H., Supvr. Bridges, L. S. & M. S. Ry., Cleveland, Ohio.
Rettinghouse, H., Div. Engr., C. & N. W. Ry., Boone, Ia.
Rhoads, John, Fire Insp., C. & N. W. Ry., Chicago.
Rice, A. P., Roadmaster, C. N. & L. R. R., Columbia, S. C.
Richey, C. W., Mast. Carp., P. R. R., Pittsburg, Pa.
Ridgway, Arthur, Asst. Ch. Engr., D. & R. G. R. R., Denver, Colo.
Riley, L. A., Engr., L. & H. R. Ry., Warwick, N. Y.
Riney, M., Gen'l For. B. and B., C. & N. W. Ry., Baraboo, Wis.
Rintoul, D. T., Gen'l For. B. and B., Sou. Pac. Co., Bakersfield, Cal.
Robertson, A. A., Supvr. B. and B., N. W. Pac. Ry., San Rafael, Cal.
Robinson, J. S., Div. Engr., C. & N. W. Ry., Chicago.
Robinson, John, Supvr. B. and B., P. M. R. R., Grand Rapids, Mich.
Rodman, G. A., For. B. and B., N. Y. N. H. & H. R. R., New Haven, Conn.
Rogers, W. A., Civil Engineer, 355 Dearborn St., Chicago.
Rogers, W. B., Supvr. B. and B., C. St. P. M. & O. Ry., Emerson, Neb.
Rohbock, W. L., Asst. to Ch. Engr., W. & L. E. R. R., Cleveland, Ohio.
Ross, William, Chief Carp., C. M. & St. P. Ry., Millbank, S. D.
Rounseville, D., Div. Engr., C. & N. W. Ry., Antigo, Wis.

Salisbury, J. W., Gen. For. Docks & Wharves, A. C. L. R. R., Port Tampa, Fla.
Sampson, G. T., Div. Engr., N. Y. N. H. & H. R. R., Boston.
Sattley, R. C., Valuation Engr., C. R. I. & P. Ry., Chicago.
Schaffer, John, Supvr. B. and B., N. Y. C. & H. R. R. R., Rochester, N. Y.
Schall, F. F., Bridge Engr., L. V. R. R., So. Bethlehem, Pa.
Schenck, W. S., Mast. Carp., B. & O. R. R., Connellsville, Pa.

Scheetz, F. B., Contracting Engr., K. C. Bridge Co., Kansas City, Mo.
Schindler, A. D., Gen'l Mgr., N. E. Ry., San Francisco, Cal.
Schuessler, W. B., Supvr. B. and B., N. Y. N. H. & H. R. R., New Haven, Conn.
Scribner, C. J., Bldg. Inspr., Mo. Pac. Ry., St. Louis, Mo.
Sefton, Thomas, Engr., Intercolonial Ry., Moncton, N. B.
Selig, A. C., Asst. Engr., Intercolonial Ry., Moncton, N. B.
Shane, A., Gen'l Mgr., I. C. & S. Trac. Co., Columbus, Ind.
Sharpe, D. W., Supvr. B. and B., N. Y. N. H. & H. R. R., New Haven, Conn.
Sharpe, T. E., Supvr. B. and B., Sou. Ry., Greenville, S. C.
Shedd, A. R., Asst. Gen'l Br. Inspr., C. & N. W. Ry., Chicago.
Sheldon, J. B., Supvr. B. and B., N. Y. N. H. & H. R. R., Providence, R. I.
Sheley, Wm., Asst. Supvr. B. and B., L. & N. R. R., Evansville, Ind.
Sherwin, F. A., Roadmaster, B. & M. R. R., Springfield, Mass.
Shope, D. A., Gen'l For. B. and B., A. T. & S. F. Ry., Fresno, Cal.
Shropshire, W., Supvr. of B. and B., Y. & M. V. R. R., Greenville, Miss.
Sibley, C. A., 82 Church St., New Haven, Conn.
Siefer, F. M., Asst. Engr., Sou. Pac. Co., Oakland Pier, Cal.
Smith, Glen B., For. Water Stations, S. A. L. Ry., Jacksonville, Fla.
Smith, G. W., American Bridge Co., Chicago.
Smith, L. D., Supvr. Bridges, S. P. Co., San Francisco, Cal.
Snow, J. P., Ch. Engr., B. & M. R. R., Boston, Mass.
Soisson, J. L., Gen'l For. B. and B., L. S. & M. S. Ry., Norwalk, Ohio.
Soles, G. H., Supvr. B. and B., P. & L. E. R. R., Pittsburg, Pa.
Spaulding, E. C., Supvr. B. and B., B. & M. R. R., St. Johnsbury, Vt.
Spencer, C. F., Supt. Const., L. I. R. R., Jamaica, N. Y.
Spencer, C. H., Engr., W. T. Co., Washington, D. C.
Spencer, William, Gen'l For. B. and B., C. & N. W. Ry., Chadron, Neb.
Stannard, James, 1602 Broadway, Kansas City, Mo.
Staten, J. M., Gen'l Bridge Insp., C. & O. Ry., Richmond, Va.
Steffens, W. F., Engr. of Structures, B. & A. R. R., Boston.
Stern, I. F., Bridge Engr., C. & N. W. Ry., Chicago.
Storck, E. G., Mast. Carp., P. & R. Ry., Philadelphia, Pa.
Strouse, W. F., Asst. Engr., B. & O. R. R., 400 Forest Road, Baltimore.
Stuart, T. J., Supvr. B. and B., W. Pac. Ry., Elko, Nev.
Sullivan, William, Kansas City, Mo.
Swain, G. F., Prof. C. E., Harvard University, Cambridge, Mass.
Swartz, A., Div. Engr., Erie R. R., Huntington, Ind.
Sweatt, B. J., Civil Engineer and Contractor, Boone, Ia.
Sweeney, Wm., For. B. and B., C. & N. W. Ry., Green Bay, Wis.
Swenson, P., Supvr. B. and B., M. St. P. & S. Ste. M. Ry., Minneapolis.

Talbott, J. L., Gen'l For. B. and B., A. T. & S. F. Ry., Pueblo, Col.
Tanner, F. W., Insp. M. of W., Mo. Pac. Ry., St. Louis, Mo.
Tanner, S. C., Mast. Carp., B. & O. R. R., Baltimore, Md.
Taylor, D. B., Mast. Carp., B. & O. R. R., Garrett, Ind.
Taylor, Herbert, Supvr. B. and B., D. & R. G. R. R., Alamosa, Colo.
Taylor, F. A., Mast. Carp., B. & O. R. R., Cumberland, Md.
Taylor, J. C., Supvr. B. and B., N. P. Ry., Glendive, Mont.
Thanheiser, C. A., Res. Engr., T. & N. O. R. R., Houston, Tex.
Thomas, C. E., Gen'l For. W. W., I. C. R. R., Chicago.
Thompson, C. S., Supt. B. and B., D. & R. G. R. R., Denver.
Thompson, C., Asst. Supvr. B. and B., E. J. & E. Ry., Gary, Ind.
Thompson, H. C., Div. Engr., N. Y. C. & H. R. R. R., Weehawken, N. J.
Thompson, F. L., Engr. B. & B., I. C. R. R., Chicago.
Thorne, J. O., Mast. Carp., C. B. & Q. Ry., Beardstown, Ill.
Toohey, J. E., Gen'l For. B. and B., P. M. R. R., Grand Rapids, Mich.
Trapnell, William, Ch. Engr., Hampshire Southern R. R., Romney, W. Va.
Travis, O. J., Beverly Dell Ranch, Bow, Wash.

Trippe, H. M., Res. Engr., C. & N. W. Ry., Chicago.
Troup, G. A., Engr., Govt. Rys., Wellington, N. Z.

Upp, J. D., Contractor, Fairbury, Neb.

Vance W. H., Engr. M. of W., La. & Ark. Ry., Stamps, Ark.
Vandegrift, C. W., C. & O. Ry., Ronceverte, W. Va.
Vaughan, James, Supvr. B. and B., D. & R. G. R. R., Salida, Colo.
Vest, W. E., Asst. Engr., Sou. Ry., Charlotte, N. C.

Wackerle, L. J., Insp., M. of W., M. P. Ry., Kansas City, Mo.
Waits, A. L., For. B. and B., St. L. I. M. & S. Ry., Argenta, Ark.
Walden, H. A., Chief Clerk, C. & N. W. Ry., Boone, Ia.
Walden, W. D., Supt. Miss. R. Bridge, C. & N. W. Ry., Clinton, Iowa.
Walker, I. O., Asst. Engr., N. C. & St. L. Ry., Paducah, Ky.
Ware, B. C., Mast. Carp., C. R. I. & P. Ry., Dalhart, Tex.
Warne, C. C., Asst. Engr., N. Y. C. & H. R. R. R., New York City.
Watson, P. N., Supvr. B. and B., Maine Central R. R., Brunswick, Me.
Wehlen, Charles, Br. Inspr., L. I. R. R., Jamaica, N. Y.
Weise, F. E., Chief Clerk, Eng. Dept., C. M. & St. P. Ry., Chicago.
Welker, G. W., Supvr. B. and B., Southern Ry., Alexandria, Va.
Wells, J. M., Gen'l For. B. and B., A. T. & S. F. Ry., Chillicothe, Ill.
Wenner, E. R., Supvr. B. and B., L. V. R. R., Ashley, Pa.
Wheaton, L. H., Div. Engr., G. T. P. Ry., Moncton, N. B.
White, I. F., Div. Engr., C. H. & D. Ry., Dayton, Ohio.
White, J. B., For. W. S., C. & N. W. Ry., Boone, Ia.
Wicks, Warren, Gen'l For. L. I. R. R., Amityville, N. Y.
Wiley, J. G., Supvr. B. and B., Sou. Pac. Co., Dunsmuir, Cal.
Williams, J. C., Supvr. B. and B., A. & W. P. Ry., Opelika, Ala.
Wilkinson, J. M., For. B. and B., C. N. R. R., Van Wert, Ohio.
Wilkinson, W. H., Bridge Insp., Erie R. R., Elmira, N. Y.
Williams, Arthur, Engr., W. & M. Ry., Wellington, N. Z.
Williams, M. R., Gen'l For. B. and B., A. T. & S. F. Ry., Las Vegas, N. M.
Wilson, M. M. Div. Br. Inspr., Sou. Pac. Co., Los Angeles.
Wilson, W. W., Div. Engr., G. C. & S. F. Ry., Galveston, Tex.
Wilson, E. E., Supvr. of Bridges, N. Y. C. & H. R. R. R., New York City, (81 E. 125th St.).
Wilson, Jas. A., Br. For., S. A. L. Ry., Woodbine, Ga.
Winter, J. L., Mast. Carp., S. A. L. Ry., Waldo, Fla.
Wise, E. F., 207 Clay St., Waterloo, Iowa.
Witt, C. C., Engr., Ry. Appraisals, Pierre, S. D.
Wolf, A. A., Dist. Carp., C. M. & St. P. Ry., Milwaukee, Wis.
Wood, W. B., Supvr. B. and B., Mo. Pac. Ry., Atchison, Kan.
Wood, J. W., Gen'l For. B. and B., A. T. & S. F. Ry., Needles, Cal.
Wood, W. E., Dist. Engr., C. M. & St. P. Ry., Chicago.
Wright, C. W., Mast. Carp., L. I. R. R., Jamaica, N. Y.
Wright, G. A., Ill. Traction System, Decatur, Ill.

Yappen, Adolph, Dist. Carp., C. M. & St. P. Ry., Chicago.
Yereance, W. B., Civil Engineer, 418 Center St., So. Orange, N. J.
Young, R. C., Chief Engr., L. S. & I. Ry., Marquette, Mich.

Zinck, K. J. C., Asst. Engr., G. T. P. Ry., Winnipeg, Manitoba.
Zinsmeister, E. C., Mast. Carp., B. & O. R. R., Zanesville, O.
Zook, D. C., Mast. Carp., Pa. Lines W. of Pitts., Ft. Wayne, Ind.

LIFE MEMBERS.

Amos, Alexander, Soo Line, Minneapolis, Minn.
Cummin, Jos. H., Bay Shore, N. Y.
Foreman, John, P. & R. Ry., Pottstown, Pa.
Gooch, C. W., 1325 W. 9th St., Des Moines, Ia.
Green, E. H. R., Texas Midland R. R., Terrell, Tex.
McIntyre, James, Miami, Fla.
Phillips, H. W., So. Braintree, Mass.
Porter, L. H., Box 35, Andover, Conn.
Travis, O. J., Bow, Wash.
Vandegrift, C. W., C. & O. Ry., Ronceverte, W. Va.
Walden, W. D., C. & N. W. Ry., Clinton, Ia.
Wise, E. F., 207 Clay St., Waterloo, Ia.

DECEASED MEMBERS.

Berg, Walter G.
Brady, James.
Carr, Charles.
Causey, T. A.
DeMars, James.
Dunlap, H.
Fletcher, H. W.
Fuller, C. E.
Gilbert, J. D.
Gilchrist, E. M.
Graham, T. B.
Hall, H. M.
Heflin, R. L.
Hinman, G. W.
Humphreys, Thos.
Isadell, L. S.
Johnson, J. E.
Keen, Wm. H.
Lantry, J. F.
Large, C. M.
Lovett, J. W.
Markley, Abel S.
McCormack, J. W.
McGehee, G. W.
Mellor, W. J.
Millner, S. S.
Mitchell, J. B.
Mitchell, W. B.
Morgan, T. H.
Morrill, H. P.
Peck, R. M.
Reid, G. M.
Renton, Wm.
Reynolds, E. F.
Robertson, Daniel
Schwartz, J. C.
Spafford, L. K.
Spangler, J. A.
Taylor, J. W.
Thompson, N. W.
Tozzer, Wm. S.
Trautman, J. J.
Van Der Hoek, J.
Wallace, J. E.
Welch, E. T.
Worden, C. G.

MEMBERSHIP AND MILEAGE OF RAILWAYS REPRESENTED.

Name of Road and Membership.	Members.	Mileage.
Arizona Eastern R. R.	1	217
C. C. Mallard, Globe, Ariz.		
Atchison, Topeka & Santa Fé Ry.	4	5,574
E. McCann, Wellington, Kan.		
John L. Talbott, Pueblo, Col.		
J. M. Wells, Chillicothe, Ill.		
M. R. Williams, Las Vegas, N. M.		
Atchison, Topeka & Santa Fé Ry. (Coast Lines)	6	1,974
R. J. Arey, Los Angeles, Cal.		
E. E. Ball, Winslow, Ariz.		
J. F. Parker, San Bernardino, Cal.		
V. C. Proctor, Winslow, Ariz.		
D. A. Shope, Fresno, Cal.		
J. W. Wood, Needles, Cal.		
Atlanta & West Point R. R. and W. Ry. of Ala.	2	225
O. T. Nelson, Montgomery, Ala.		
J. C. Williams, Opelika, Ala.		
Atlantic Coast Line R. R.	1	4,361
J. W. Salisbury, Port Tampa, Fla.		
Baltimore & Ohio R. R. and B. & O. S. W. R. R.	11	4,449
G. W. Andrews, Baltimore, Md.		
W. M. Clark, Pittsburg, Pa.		
W. T. Hopke, Grafton, W. Va.		
J. T. McIlwain, Akron, O.		
W. S. Schenck, Connellsville, Pa.		
W. F. Strouse, Baltimore, Md.		
S. C. Tanner, Baltimore, Md.		
D. B. Taylor, Garrett, Ind.		
F. A. Taylor, Cumberland, Md.		
Wm. Trapnell, Baltimore, Md.		
E. C. Zinsmeister, Zanesville, O.		
Baltimore & Ohio, Chicago Terminal R. R.	1	289
E. N. Layfield, Chicago, Ill.		
Bangor & Aroostook R. R.	2	603
W. E. Alexander, Houlton, Me.		
M. Burpee, Houlton, Me.		
Bessemer & Lake Erie R. R.	1	210
H. D. Cleaveland, Greenville, Pa.		

Name of Road and Membership.	Members.	Mileage.
Boston & Albany R. R.	1	392
W. F. Steffens, Boston, Mass.		
Boston & Maine R. R.	16	2,288
Cyrus P. Austin, Lawrence, Mass.		
C. C. Battey, Concord, N. H.		
J. P. Canty, Fitchburg, Mass.		
John Ewart, Boston, Mass.		
Andrew B. Hubbard, Boston, Mass.		
F. J. Leavitt, Sanbornville, N. H.		
William A. Lydston, Salem, Mass.		
John Marsh, Lawrence, Mass.		
Albert Mountfort, Nashua, N. H.		
A. A. Page, Wilmington, Mass.		
S. F. Patterson, Concord, N. H.		
B. F. Pickering, Salem, Mass.		
Fred C. Rand, Boston, Mass.		
F. A. Sherwin, Springfield, Mass.		
J. P. Snow, Boston, Mass.		
E. C. Spaulding, St. Johnsbury, Vt.		
Canadian Pacific Ry.	4	9,878
F. P. Gutelius, North Bay, Ont.		
C. N. Monsarrat, Montreal, P. Q.		
P. B. Motley, Montreal P. Q.		
Frank Lee, Winnipeg, Man.		
Carolina & Northwestern Ry.	1	133
J. W. Fletcher, Jr., Chester, S. C.		
Central of Georgia Ry.	2	1,916
A. M. Dodd, Columbus, Ga.		
H. C. McKee, Macon, Ga.		
Central R. R. of New Jersey	1	646
George F. Morse, New York City.		
Central Vermont Ry.	4	536
J. E. Cole, St. Albans, Vt.		
C. Donaldson, Waterbury, Vt.		
C. F. Flint, St. Albans, Vt.		
H. E. Holmes, New London, Conn.		
Chattanooga Southern R. R.	1	98
C. H. Fisk, Chattanooga, Tenn.		
Chesapeake & Ohio Ry.	5	2,027
F. M. Griffith, Covington, Ky.		
Oscar L. Grover, Richmond, Va.		
C. E. Powell, Hinton, W. Va.		
J. M. Staten, Richmond, Va.		
C. W. Vandegrift, Ronceverte, W. Va.		
Chicago & Alton R. R.	1	998
H. H. Eggleston, Bloomington, Ill.		
Chicago & Eastern Illinois R. R.	1	957
A. S. Markley, Danville, Ill.		
Chicago & North Western Ry.	34	7,926
L. J. Anderson, Escanaba, Mich.		
H. Bender, Eagle Grove, Ia.		
F. L. Burrell, Fremont, Neb.		

Name of Road and Membership.	Members.	Mileage.
Chicago & North Western Ry. Continued.		
A. J. Colwell, Norfolk, Neb.		
Henry Crane (retired), Janesville, Wis.		
H. H. Decker, Winona, Minn.		
T. H. Durfee, Huron, S. D.		
W. H. Finley, Chicago, Ill.		
M. J. Flynn, Chicago, Ill.		
G. W. Hand, Chicago, Ill.		
John Hunciker, Chicago, Ill.		
Lee Jutton, Chicago, Ill.		
C. F. King, Shoshoni, Wyo.		
C. A. Lichty, Chicago, Ill.		
George Loughnane, Escanaba, Mich.		
W. T. Main, Chicago, Ill.		
C. A. Marcy, Chicago, Ill.		
A. W. Merrick, Boone, Ia.		
W. F. Meyers, Belle Plaine, Ia.		
J. D. Moen, Boone, Ia.		
J. A. S. Redfield, Hawarden, Iowa.		
H. Rettinghouse, Boone, Ia.		
John Rhoads, Chicago,		
M. Riney, Baraboo, Wis.		
J. S. Robinson, Chicago, Ill.		
D. Rounseville. Antigo, Wis.		
A. R. Shedd, Chicago, Ill.		
Wm. Spencer, Chadron, Nebr.		
I. F. Stern, Chicago, Ill.		
W. M. Sweeney, Green Bay, Wis.		
H. M. Trippe, Chicago, Ill.		
H. A. Walden, Boone, Ia.		
W. D. Walden, (retired), Clinton, Ia.		
J. B. White, Boone, Ia.		
Chicago Burlington & Quincy R. R.	3	8,950
Geo. Fenney, McCook, Neb.		
W. Hurst, St. Joseph, Mo.		
J. O. Thorne, Beardstown, Ill.		
Chicago Great Western R. R.	1	1,471
W. B. Causey, Chicago, Ill.		
Chicago, Indianapolis & Louisville Ry.	1	578
J. M. Caldwell, Lafayette, Ind.		
Chicago, Milwaukee & St. Paul Ry.	13	8,856
(and C. M. & P. S. Ry.)		
E. J. Auge, Wells, Minn.		
A. G. Bennett, Minneapolis, Minn.		
H. R. Drum, Chamberlain, S. D.		
T. L. D. Hadwen, Chicago, Ill.		
F. E. King, Milwaukee, Wis.		
N. H. LaFountain, Chicago, Ill.		
C. F. Loweth, Chicago, Ill.		
S. W. McCaulley, Bacon, Wis.		
William Ross, Milbank, S. D.		
Fred E. Weise, Chicago, Ill.		
William E. Wood, Chicago, Ill.		
A. A. Wolf, Milwaukee, Wis.		
A. Yappen, Chicago, Ill.		

Name of Road and Membership.	Members.	Mileage.
Chicago, Rock Island & Pacific Ry.	5	7,396
McClellan Bishop, El Reno. Okla.		
C. H. Eggers, Little Rock, Ark.		
E. R. Floren, Fairbury, Neb.		
M. E. Gumphrey, Eldon, Mo.		
B. M. Hudson, Amarillo, Tex.		
Chicago, St. Paul, Minneapolis & Omaha Ry.	2	1,739
G. Larson, Hudson, Wis.		
W. B. Rogers, Emerson, Neb.		
Chicago, Terre Haute & Southeastern Ry.	1	351
J. Dupree, Crete, Ill.		
J. O. Jewell, Terre Haute, Ind.		
Cincinnati, Hamilton & Dayton Ry.	2	1,038
J. W. Anderson, Chillicothe, O.		
I. F. White, Dayton, O.		
Cincinnati Northern R. R.	1	236
J. M. Wilkinson, Van Wert, O.		
Colorado & Southern Ry.	5	1,250
R. W. Beeson, Trinidad, Colo.		
C. W. Fellows, Denver, Colo.		
Harry James, Denver, Colo.		
A. W. Pauba, Denver, Colo.		
W. T. Powell, Denver, Colo.		
Columbia, Newberry & Laurens R. R.	1	75
A. P. Rice, Columbia, S. C.		
Copper Range R. R.	1	128
A. Giesing, Houghton, Mich.		
Denver & Rio Grande R. R.	4	2,598
A. Ridgway, Denver, Colo.		
H. Taylor, Alamosa, Colo.		
C. S. Thompson, Denver, Colo.		
Jas. Vaughan, Salida, Colo.		
Denver, Enid & Gulf R. R.	1	120
J. D. Lacy, Enid, Okla.		
Duluth & Iron Range R. R.	2	168
W. A. Clark, Duluth, Minn.		
B. T. McIver, Two Harbors, Minn.		
Duluth, Missabe & Northern Ry.	1	275
W. A. McGonagle, Duluth, Minn.		
Duluth, South Shore & Atlantic Ry.	1	586
W. M. Noon, Marquette, Mich.		
Elgin, Joliet & Eastern Ry.	3	770
G. H. Jennings, Joliet, Ill.		
A. Montzheimer, Joliet, Ill.		
C. Thompson, Gary, Ind.		
El Paso & Southwestern System	1	903
Bailey J. Mustain, Eichel, N. M.		

Name of Road and Membership.	Members.	Mileage.
Erie R. R. (and Chicago & Erie)	8	2,499
O. F. Barnes, Susquehanna, Pa.		
W. O. Eggleston, Huntington, Ind.		
A. J. Horth, Meadville, Pa.		
F. A. Knapp, Jersey City, N. J.		
W. H. Matthews, Hornell, N. Y.		
Neil McLean, Huntington, Ind.		
A. Swartz, Huntington, Ind.		
W. H. Wilkinson, Elmira, N. Y.		
Florida East Coast Ry.	1	738
E. K. Barrett, St. Augustine, Fla.		
Fort Smith & Western R. R.	1	217
B. F. Beckman, Ft. Smith, Ark.		
Fort Worth & Denver City Ry.	1	454
J. M. Mann, Ft. Worth, Tex.		
Galveston, Harrisburg & San Antonio Ry. and Texas & New Orleans R. R.	1	1,797
C. A. Thanheiser, Houston, Tex.		
Grand Rapids & Indiana Ry.	2	592
W. S. McKeel, Grand Rapids, Mich.		
H. M. Large, Ft. Wayne, Ind.		
Grand Trunk Ry. System	2	4,745
A. Findley, Montreal, Que.		
George A. Mitchell, Toronto, Ont.		
Grand Trunk Pacific Ry.	1	2,440
K. J. C. Zinck, Winnipeg, Man.		
Gulf, Colorado and Santa Fé Ry.	5	1,518
E. C. George, Beaumont, Tex.		
K. S. Hull, Temple, Tex.		
R. A. Luker, Silsbee, Tex.		
W. G. Massenburg, Beaumont, Tex.		
W. W. Wilson, Galveston, Tex.		
Illinois Central R. R.	9	4,550
P. Aagaard, Chicago, Ill.		
F. O. Draper, Chicago, Ill.		
T. J. Fullem, Chicago, Ill.		
R. J. McKee, Freeport, Ill.		
Samuel P. Munson, Mattoon, Ill.		
William Reed, Grenada, Miss.		
C. E. Thomas, Chicago, Ill.		
F. L. Thompson, Chicago, Ill.		
E. F. Wise (retired), Waterloo, Ia.		
Illinois Traction System	1	420
G. A. Wright, Decatur, Ill.		
Intercolonial Ry.	8	1,447
T. C. Burpee, Moncton, N. B.		
John Forbes, Halifax, N. S.		
Hugh Jardine, Moncton, N. B.		
A. E. Killam, Moncton, N. B.		
H. J. McGrath, Moncton, N. B.		

Name of Road and Membership.	Members.	Mileage.
Intercolonial Ry. Continued.		
W. B. McKenzie, Moncton, N. B.		
Thomas Sefton, Moncton, N. B.		
A. C. Selig, Moncton, N. B.		
International & Great Northern Ry.	1	1,106
H. M. Jack, Palestine, Tex.		
Kansas City, Clinton & Springfield Ry.	1	155
J. B. Brown, Clinton, Mo.		
Lake Erie & Western Ry.	1	882
J. N. Penwell, Tipton, Ind.		
Lake Shore & Michigan Southern Ry.	4	1,529
Willard Beahan, Cleveland, O.		
Philip O'Neill, Adrian, Mich.		
R. H. Reid, Cleveland, O.		
J. L. Soisson, Norwalk, O.		
Lake Superior & Ishpeming Ry., Munising Ry., and Marquette & S. E. Ry.	2	160
August Anderson, Marquette, Mich		
Roscoe C. Young, Marquette, Mich.		
Lehigh & Hudson River Railway	2	96
J. E. Barrett, Warwick, N. Y.		
Lewis A. Riley, Warwick, N. Y.		
Lehigh Valley R. R.	7	1,446
E. B. Ashby, New York City.		
W. E. Harwig, Phillipsburg, N. J.		
Peter Hofecker, Auburn, N. Y.		
Judson Joslin, Auburn, N. Y.		
David A. Keefe, Athens, Pa.		
F. E. Schall, South Bethlehem, Pa.		
E. R. Wenner, Ashley, Pa.		
Liberty-White R. R.	1	45
J. T. Burke, McComb, Miss.		
Long Island R. R.	4	392
C. F. Spencer, Jamaica, N. Y.		
Chas. Wehlen, Jamaica, N. Y.		
W. Wicks, Amityville, N. Y.		
C. W. Wright, Jamaica, N. Y.		
Louisiana & Arkansas Ry.	1	255
W. H. Vance, Stamps, Ark.		
Louisville & Nashville R. R.	6	4,450
J. M. Bibb, Birmingham, Ala.		
A. J. Catchot, Ocean Springs, Miss.		
R. O. Elliott, Columbia, Tenn.		
Floyd Ingram, Erin, Tenn.		
A. B. McVay, Evansville, Ind.		
Wm. Sheley, Evansville, Ind.		
Maine Central R. R.	1	931
P. N. Watson, Brunswick, Me.		

Name of Road and Membership.	Members.	Mileage.
Michigan Central R. R.	4	1,746
S. D. Bailey, Detroit, Mich.		
Thomas Hall, St. Thomas, Ont.		
Henry A. Horning, Jackson, Mich.		
J. T. Webster, St. Thomas, Ont.		
Minneapolis & St. Louis R. R.	1	1,027
Ed. Gagnon, Minneapolis, Minn.		
Minneapolis, St. Paul & Sault Ste. Marie Ry.	3	3,540
A. Amos, Minneapolis, Minn.		
P. Swenson, Minneapolis, Minn.		
G. A. Manthey, Minneapolis, Minn.		
Miss. River & Bonne Terre Ry.	1	46
C. H. Fake, Bonne Terre, Mo.		
Missouri, Kansas & Texas Ry.	2	3,073
F. W. Bailey, Denison, Tex.		
J. G. Gossett, Denison, Tex.		
Missouri Pacific Ry. System (including St. Loui Mountain & Southern Ry.)	11	7.170
Robert J. Bruce, St. Louis, Mo.		
J. A. Costolo, St. Louis, Mo.		
W. Hausgen, Sedalia, Mo.		
E. P. Hawkins, Bastrop, La.		
John Larson, St. Louis, Mo.		
G. W. Land, Eudora, Ark.		
C. J. Scribner, St. Louis, Mo.		
F. W. Tanner, St. Louis, Mo.		
L. J. Wackerle, Kansas City, Mo.		
A. L. Waits, Argenta, Ark.		
W. B. Wood, Atchison, Kan.		
Nashville, Chattanooga & St. Louis Ry.	1	1,230
I. O. Walker, Paducah, Ky.		
National Rys. of Mexico	1	5,262
Hans Bentele, Mexico City, Mex.		
New South Wales Government Rys.	1	3,472
James Fraser, Sydney, N. S. W.		
New York Central & Hudson River R. R.	9	2,829
G. J. Klumpp, Rochester, N. Y.		
R. P. Mills, New York City.		
Kemper Peabody, N. Y. City.		
W. A. Pettis, Rochester, N. Y.		
Edward Rykenboer, Rochester, N. Y.		
John Schaffer, Rochester, N. Y.		
H. C. Thompson, Weehawken, N. J.		
C. C. Warne, New York City.		
E. E. Wilson, New York City.		
New York, New Haven & Hartford R. R.	13	2,044
Grosvenor Aldrich, Readville, Mass.		
J. S. Browne, Providence, R. I.		
Wm. Graham, New Haven, Conn.		
H. H. Kinzie, Taunton, Mass.		
Wm. H. Moore, New Haven, Conn.		
B. P. Phillips, Willimantic, Conn.		

Name of Road and Membership.	Members.	Mileage.
New York, New Haven & Hartford R. R. Continued.		
H. W. Phillips (retired), South Braintree, Mass.		
L. H. Porter (retired), Andover, Conn.		
George A. Rodman, New Haven, Conn.		
George T. Sampson, Boston, Mass.		
W. B. Schuessler, New Haven, Conn.		
D. W. Sharpe, New London, Conn.		
J. B. Sheldon, Providence, R. I.		
New York, Ontario & Western R. R.	1	494
J. H. Nuelle, Norwich, N. Y.		
New Zealand Government Rys.	2	2,717
C. H. Biss, Christchurch, N. Z.		
George A. Troup, Wellington, New Zealand.		
Norfolk & Southern Ry.	1	602
Thomas W. Cothran, Greenwood, S. C.		
Northern El[illegible]y.	1	130
A. D. [illegible]r, San Francisco, Cal.		
Northern Pacific Ry.	6	5,849
F. R. Bartles, Fargo, N. D.		
James Hartley, Staples, Minn.		
F. Ingalls, Jamestown, N. D.		
C. S. McCully, Jamestown, N. D.		
R. E. McFarlane, Duluth, Minn.		
J. C. Taylor, Glendive, Mont.		
North Western Govt. Rys. (India)	1	4,431
D. M. Cookson, Kalaw, Burma, India.		
Northwestern Pacific R. R.	1	372
A. A. Robertson, San Rafael, Cal.		
Oregon Short Line R. R.	1	1,508
A. H. King, Salt Lake City, Utah.		
Pennsylvania Lines West of Pittsburg	7	2,763
Samuel C. Bowers, Steubenville, O.		
Stanton Bowers, Bradford, O.		
B. F. Gehr, Richmond, Ind.		
A. F. Miller, Chicago, Ill.		
D. G. Musser, Wellsville, O.		
H. H. Pollock, Carnegie, Pa.		
D. C. Zook, Fort Wayne, Ind.		
Pennsylvania R. R.	6	5,304
M. M. Barton, West Philadelphia, Pa.		
J. A. Blair, Pittsburg, Pa.		
Richard G. Develin, Philadelphia, Pa.		
H. R. Leonard, Philadelphia, Pa.		
Robert McKibbon, Altoona, Pa.		
C. W. Richey, Pittsburg, Pa.		
Pere Marquette R. R.	6	2,336
J. D. Black, Saginaw, Mich.		
Edw. Guild, Grand Ledge, Mich.		
G. E. Hanks, East Saginaw, Mich.		
A. McNab, Holland, Mich.		
John Robinson, Grand Rapids, Mich.		
J. E. Toohey, Grand Rapids, Mich.		

Name of Road and Membership.	Members.	Mileage.
Philadelphia & Reading Ry.	4	1,476
Amos H. Beard, Reading, Pa.		
John Foreman (retired), Pottstown, Pa.		
W. W. Perry, Williamsport, Pa.		
E. G. Storck, Philadelphia, Pa.		
Pittsburg & Lake Erie R. R.	2	191
D. L. McKee, McKee's Rocks, Pa.		
G. H. Soles, Pittsburg, Pa.		
Queen & Crescent Route	1	509
E. L. Loftin, Vicksburg, Miss.		
Quincy, Omaha & Kansas City R. R.	1	261
T. F. DeCapito, Milan, Mo.		
San Pedro Los Angeles & Salt Lake R. R.	2	1,075
F. M. Bigelow, Salt Lake City, Utah.		
W. C. Frazier, Los Angeles, Cal.		
Seaboard Air Line Ry.	11	3,013
W. M. Barker, Scotia, S. C.		
M. F. Cahill, Jacksonville, Fla.		
P. W. Cahill, Tallahassee, Fla.		
B. B. Christy, Tallahassee, Fla.		
W. J. Gooding, Jr., Jacksonville, Fla.		
B. Land, Jr., Jacksonville, Fla.		
W. A. McDearmid, Tallahassee, Fla.		
J. C. Nelson, Portsmouth, Va.		
G. B. Smith, Jacksonville, Fla.		
J. A. Wilson, Woodbine, Fla.		
J. L. Winter, Waldo, Fla.		
St. Joseph & Grand Island Ry.	1	319
O. H. Andrews, St. Joseph, Mo.		
St. Louis & San Francisco R. R.	1	4,740
F. G. Jonah, St. Louis.		
St. Louis, Rocky Mt. & Pac. R. R.	1	106
Alf Brown, Raton, N. M.		
St. Louis Southwestern Ry.	2	1,451
J. S. Berry, St. Louis, Mo.		
Wm. Quinn, Tyler, Tex.		
Southern Ry.	13	7,050
D. A. Ballenger, Greenville, S. C.		
J. H. Blackwell, Charleston, S. C.		
James T. Carpenter, Princeton, Ind.		
G. W. Detter, Charleston, S. C.		
W. F. Fraylick, Charleston, S. C.		
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T. E. Sharpe, Greenville, S. C.		
G. W. Welker, Alexandria, Va.		
W. E. Vest, Charlotte, N. C.		

Name of Road and Membership.	Members.	Mileage.
Southern Pacific Company	15	6,450
T. W. Bratten, West Oakland, Cal.		
D. Burke, Tucson, Ariz.		
W. S. Corbin, Los Angeles, Cal.		
B. F. Ferris, Los Angeles, Cal.		
Neil Fraser, Sacramento, Cal.		
Jas. Gratto, Los Angeles, Cal.		
C. F. Green, Sacramento, Cal.		
P. N. Nelson, San Francisco, Cal.		
H. Pollard, San Francisco, Cal.		
Geo. W. Rear, San Francisco, Cal.		
D. T. Rintoul, Bakersfield, Cal.		
F. M. Siefer, Oakland Pier, Cal.		
L. D. Smith, San Francisco, Cal.		
J. G. Wiley, Dunsmuir, Cal.		
M. M. Wilson, Los Angeles, Cal.		
Tennessee Central R. R.	1	326
E. M. Carter, Nashville, Tenn.		
Texas & Gulf Ry.	1	97
K. S. Hull, Longview, Tex.		
Texas & Pacific Ry.	1	1,885
E. Loughery, Marshall, Tex.		
Texas Midland R. R.	1	125
E. H. R. Green, Terrell, Tex.		
Toledo, Peoria & Western Ry.	1	248
J. H. Markley, Peoria, Ill.		
Union Pacific R. R.	2	3,411
Wm. A. Conklin, Omaha, Neb.		
J. Parks, Denver, Colo.		
Vandalia R. R.	1	829
J. L. McKee, Spencer, Ind.		
Wabash R. R.	2	2,514
A. O. Cunningham, St. Louis, Mo.		
William S. Danes, Peru, Ind.		
Washington Terminal Co.	2	53
W. M. Cardwell, Washington, D. C.		
C. H. Spencer, Washington, D. C.		
Wellington & Manawata Ry. (New Zealand)	1	84
Arthur Williams, Wellington, New Zealand.		
Western Australia Government Rys.	2	1,943
W. J. George, Perth, Western Australia.		
E. S. Hume, Fremantle, Western Australia.		
Western Pacific Ry.	1	934
T. J. Stuart, Elko, Nev.		
Wheeling & Lake Erie R. R.	2	496
Wm. Mahan, Canton, O.		
W. L. Rohbock, Cleveland, O.		
Yazoo & Miss. Valley R. R.	2	1,370
D. H. Holdridge, Vicksburg, Miss.		
W. Shropshire, Greenville, Miss.		
No. of members with roads	375	
Total mileage represented		214,920
Other members not connected with roads	53	
Total number of members	428	

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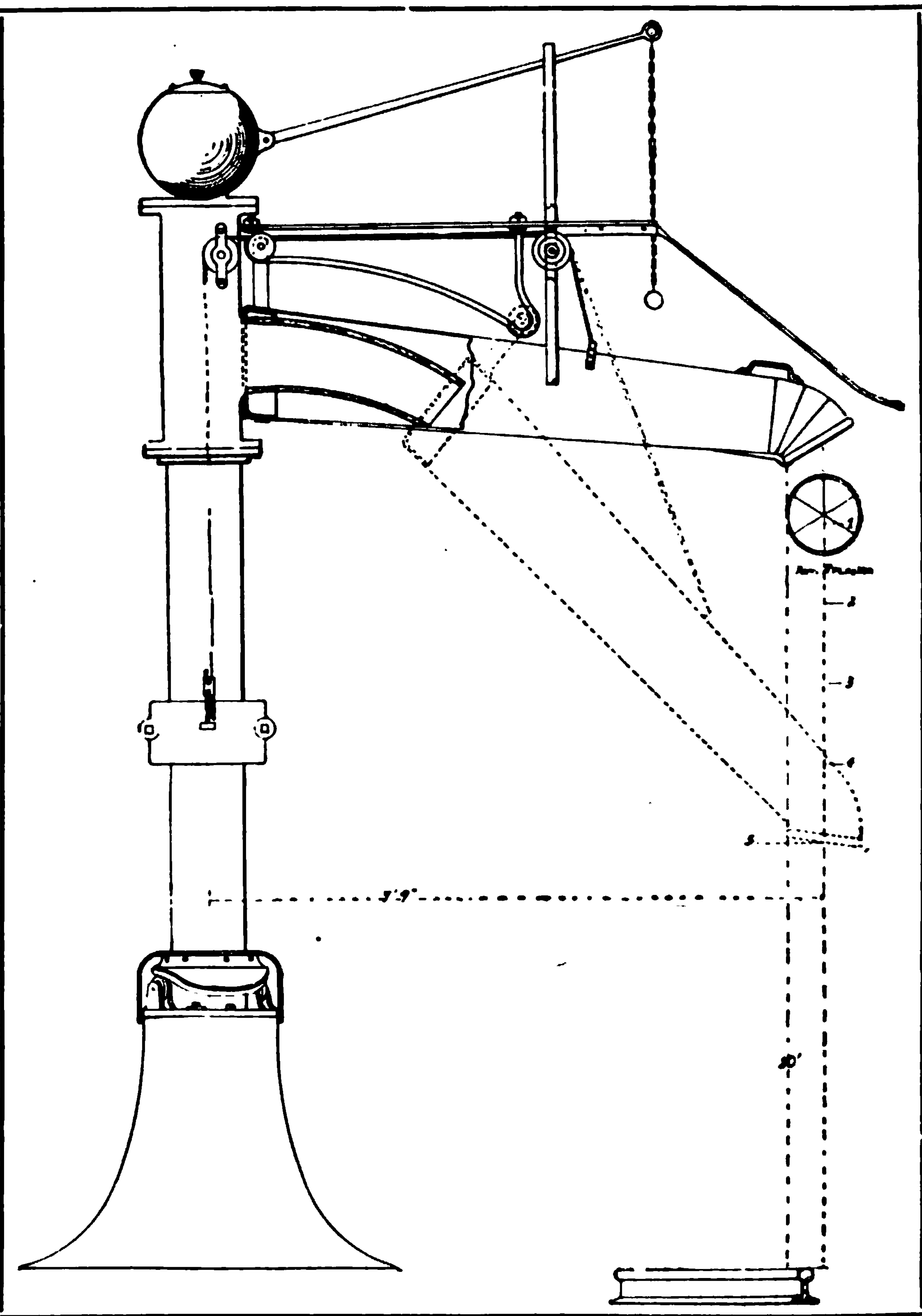

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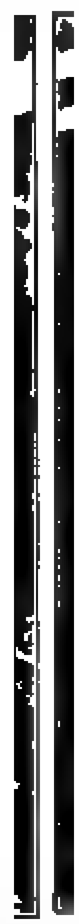

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PROCEEDINGS OF THE

Twenty-first Annual Convention

OF THE

American Railway Bridge and Building Association

HELD AT

ST. LOUIS, MISSOURI

October 17-19, 1911

REPORTS IN THIS ISSUE

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Pumping Engines
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Brick Veneer for Station Buildings
Roofs and Roof Coverings

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C. A. Lichty, Secretary
226 W. JACKSON BOULEVARD
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PROCEEDINGS OF THE

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OF THE

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION

Successor to the

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS

HELD AT

ST. LOUIS, MISSOURI

OCTOBER 17-19, 1911

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1912

F. E. SCHALL
President, 1911-12

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Southern Ry.

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*Deceased.

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   Lee Jutton, C. & N. W. Ry., Chicago, Ill.
   W. H. Moore, N. Y. N. H. & H. R. R., New Haven, Conn.

2. Derricks and Other Appliances for Handling Material in Supply Yards.

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   D. B. Taylor, B. & O. R. R., Wheeling, W. Va.
   E. A. Stanley, Mo. Pac. Ry., St. Louis, Mo.

3. Sash,—Size and Kind of Glass for Round Houses and Shops.

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   H. Bender, C. & N. W. Ry., Eagle Grove, Ia.
   P. E. Schneider, M. C. R. R., Jackson, Mich.
   F. L. Thompson, I. C. R. R., Chicago, Ill.

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   F. E. Weise, C. M. & St. P. Ry., Chicago, Ill.
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   W. M. Clark, B. & O. R. R., Pittsburgh, Pa.
   D. G. Musser, Pa. Lines W. of Pitts., Wellsville, Ohio.

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   J. Dupree, C. T. H. & S. E. Ry., Crete, Ill.
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   H. H. Decker, C. & N. W. Ry., Winona, Minn.
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   George Loughnane, C. & N. W. Ry., Escanaba, Mich.

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   B. J. Mustain, E. P. & S. W. R. R., El Paso, Tex.
   E. S. Hume, W. A. Govt. Rys., Midland Jct., W. Australia.
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   D. Burke, Southern Pacific Co., Tucson, Ariz.
   W. C. Dale, O. S. L. R. R., Salt Lake City.

9. The Development of Turntables to Meet Operating Conditions for the Modern Locomotive, showing most improved practice.
   C. E. Smith, Mo. Pac. Ry., St. Louis, Mo.
   J. S. Berry, S. L. S. W. Ry., St. Louis, Mo.
   F. G. Jonah, St. L. & S. F. R. R., St. Louis, Mo.
   A. S. Markley, C. & E. I. R. R., Danville, Ill.
   C. H. Fake, M. R. & B. T. R. R., Bonne Terre, Mo.

10. Track Scales—Construction and Maintenance.
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    H. M. Jack, I. & G. N. R. R., Palestine, Tex.

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    O. F. Barnes, Erie R. R., Susquehanna, Pa.
    O. F. Dalstrom, C. & N. W. Ry., Chicago, Ill.

12. Relative Merits of Brick and Concrete in Railway Buildings and Platforms.

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D. G. Musser, Pa. Lines W. of Pitts., Wellsville, Ohio.
P. E. Schneider, M. C. R. R., Jackson, Mich.

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J. J. Taylor, K. C. S. Ry., Texarkana, Tex.

PUBLICATIONS.

R. C. Sattley, C. R. I. & P. Ry., Chicago, Ill.
A. Montzheimer, E. J. & E. Ry., Joliet, Ill.
Lee Jutton, C. & N. W. Ry., Chicago, Ill.

ARRANGEMENTS.

G. W. Andrews, B. & O. R. R., Baltimore, Md.
W. F. Strouse, B. & O. R. R., Baltimore, Md.
S. C. Tanner, B. & O. R. R., Baltimore, Md.

OBITUARY.

J. N. Penwell, L. E. & W. R. R., Tipton, Ind.

Proceedings of the Twenty-first Annual Convention

OF THE

American Railway Bridge and Building Association

HELD IN THE PLANTERS HOTEL

St. Louis, Mo., October 17, 18 and 19, 1911

MORNING SESSION.

Tuesday October, 17, 1911.

The twenty-first annual convention of the association was called to order at 10 A. M., by President H. Rettinghouse.

Prayer was offered by Mr. J. N. Penwell.

The President:—We have with us today Mr. John Gundlach, president of the city council, who, in the absence of the mayor, will welcome us and tender us the keys of the city.

Mr. Gundlach:—Mr. President, ladies and gentlemen: It is the privilege of the chief executive of this city to confer the freedom of the city upon conventions that meet here. We have conventions of all kinds, some of which affect the public interest and public welfare more or less. I want to say that I am particularly delighted to note the promiscuousness, or rather the number of ladies present at this convention. I want to say, for the information of the ladies, that this city always feels safer with a convention that is attended by a large number of ladies. We know, however, that they are a deterrent on the exuberance of some of the convention delegates.

The mayor of the city is not able to be present, because this is the day of the annual police parade, and I want to say right here that I hope you will not connect the parade of the police with your convention; it is an annual custom and is simply a coincidence. I do not believe it will be necessary to call on the police during your presence here, on account of the great number of ladies that are present (Laughter).

Ladies and gentlemen, to be serious, in extending to you a wel-

come to the city, I do not mean to convey it as a mere matter of form, for I know, and I want you to feel, that every citizen in St. Louis is glad to welcome you and would have you carry away a good impression of the city. We do not claim to be Utopians. I do not think that you will find St. Louis to be the Utopia of civilization, but we have a great many things that will appeal to you and things which make St. Louis a very attractive city. We are a large commercial city, perhaps more so than is evident to the average person who visits us; but if there is one thing that we are proud of, it is our homes, and those of you who are not familiar with this city, we invite to make an inspection of our homes. I think that if you carry away the correct impression of our homes you will get the best possible benefit from having visited the city.

Such a convention as this, of such a universal character, and of such wide-spread interest to the community, is really one of great importance. Every delegate to this convention should realize that your work is not merely mechanical, but brings into play a constructive intelligence that is of benefit to the whole community. The experience from year to year should teach us to do better.

Speculative railroad building has, fortunately or unfortunately, given place to investment railroading. It is a hopeful sign of the times that people are not going to build railroads just simply for the purpose of personal advancement or personal interest, but that the railroading of the future must be for the benefit of the community. The interest of the individual must always be merged with the interest of the community, for the greatest interest of the individual is the community interest, that being a bequest to posterity.

I trust that your deliberations while here will be marked with that degree of seriousness which you gentlemen can appreciate perhaps better than I, and that the convention will be an instructive one. I hope that the committee of arrangements will provide a series of entertainments which will make you forget your homes, temporarily, and that when you leave it will be with the hope of coming back at some future time and with a desire to tell your friends that St. Louis is a very good place to come to. I thank you (Applause).

The President:—I will call on one of our older members, Mr. Geo. W. Andrews, to respond to the address of Mr. Gundlach.

Mr. Andrews:—Mr. Gundlach, Mr. President, ladies and gentlemen: About ten minutes before we convened our president came

to me and said that he desired me to respond to the address of the mayor of St. Louis. While I regret very much that the mayor has been unable to attend, we certainly feel very grateful that he has sent such a worthy representative. I would say that we are not strangers to St. Louis. Twenty years ago a small number of men met in St. Louis and organized this association. We feel, therefore, that instead of being strangers in St. Louis, this organization is simply a child of St. Louis, and we have a full right to expect open arms from our mother. We have been received with open arms by all cities to which we have gone to hold our conventions, but we feel that we have a special right to demand open arms in St. Louis, and we are very glad indeed to come here.

If you will permit me to digress for a moment, I will give you a little story that I heard only a few days ago relative to "open arms." It appears that in an old colored church in one of the southern cities, presided over by Parson Johnson, the parson was one day caught embracing one of the ewe lambs of his congregation and the elders took exception. They called the old gentleman before the board, investigated the affair and asked him to state his reasons for embracing the handsomest ewe lamb in the congregation, and his response was: " Brethren, haven't you never seen the picture of the good man with the lamb in his arms? If the good man sets the example to us with the lamb in his arms, why shouldn't your parson have the lamb in his arms?" The deacons, after considering the matter, decided about as follows: " Whereas, it may be necessary for Parson Johnson to have a lamb in his arms, therefore, be it resolved, that when it does become necessary for Parson Johnson to have a lamb in his arms, that he make that lamb a ram lamb" (Applause). I think, Mr. President, that is one of the reasons a great many of us bring our wives to the convention (Laughter).

Now, Mr. Gundlach, I will not tire the association, nor you, but I will say, on behalf of the association, that we thank you, as the representative of St. Louis, for your hearty welcome, and I sincerely hope that we will make this the meeting place of each and every one of our ten-year anniversary conventions.

The President:—The next matter in order is the roll call which, however, is handled by a system of registration, and I ask every member who has not yet registered to do so as speedily as possible and to be sure about doing so, in order that no one will be missed. The registration cards are at the entrance to the convention hall. The registration showed the following members present:

Members Present at the 1911 Convention.

Aagaard, P., Supvr. B. & B., I. C. R. R. Chicago.
Aldrich, G., Supvr. B. & B., N. Y. N. H. & H. R. R., Boston.
Anderson, A., Gen. For. B. & B., L. S. & I. Ry., Marquette, Mich.
Andrews, G. W., Insp. Maint., B. & O. R. R., Baltimore, Md.
Beard, A. H. For. Carp., P. & R. Ry., Reading, Pa.
Bender, H., For. B. & B., C. & N. W. Ry., Eagle Grove, Ia.
Bibb, J. M., Supvr. B. & B., L. & N. R. R., Birmingham, Ala.
Bishop, M., Mast. Carp., C. R. I. & P. Ry., El Reno, Okla.
Bowers, Stanton, Mast. Carp., P. C. C. & St. L. Ry., Bradford, O.
Bowers, S. C., Mast. Carp. of Brs., P. C. C. & St. L. Ry., Steubenville, O.
Browne, J. B., Gen. For. B. & B., K. C. C. & S. Ry., Clinton, Mo.
Bruce, R. J., Supt. Bldgs., Mo. Pac. Ry., St. Louis, Mo.
Cardwell, W. M., Mast. Carp. Wash. Term. Co., Washington, D. C.
Carter, E. M., Supvr. B. & B., T. C. R. R., Nashville, Tenn.
Costolo, J. A., Insp. Trans. Boats, M. P. Ry., St. Louis, Mo.
Cunningham, A. O., Ch. Engr., Wabash R. R., St. Louis, Mo.
Dupree, J., Supt. W. S., C. T. H. & S. E. Ry., Crete, Ill.
Eggleston, W. O., Br. Inspr., Erie R. R., Huntington, Ind.
Elliott, R. O., Supvr. B. & B., L. & N. R. R., Nashville, Tenn.
Fake, C. H., Ch. Engr., M. R. & B. T. R. R., Bonne Terre, Mo.
Ferdina, A. H., For. B. & B., St. L. I. M. & S. Ry., St. Louis.
Frazier, W. C., Supvr. B. & B., S. P. L. A. & S. L. R. R., Los Angeles.
Fullem, T. J., Supt., Buildings, I. C. R. R., Chicago.
Griffith, F. M., Supt. B. & B., C. & O. Ry., Covington, Ky.
Guild, Edw., Supt. B. & B., P. M. R. R., Grand Ledge, Mich.
Gumphrey, M. E., Mast. Carp., C. R. I. & P. Ry., Eldon, Mo.
Hadwen, L. D., Eng. Mas. Con., C. M. & St. P. Ry., Chicago.
Hand, G. W., Asst. Engr., C. & N. W. Ry., Chicago.
Hausgen, W., Supvr. B. & B., Mo., Pac. Ry., Sedalia, Mo.
Hofecker, P., Supvr. B. & B., L. V. R. R., Auburn, N. Y.
Hall, Thos., Div. For., M. C. R. R., St. Thomas, Ont.
Hopke, W. T., Mast. Carp., B. & O. R. R., Grafton, W. Va.
Horning, H. A., Supt. B. & B., M. C. R. R., Jackson, Mich.
Jewell, J. O., Supt. B. & B., C. T. H. & S. E. Ry., Terre Haute, Ind.
Jonah, F. G., Ch. Engr. Const., Frisco Lines, St. Louis.
Jutton, Lee, Gen. Insp. Bridges, C. & N. W. Ry., Chicago.
Killam, A. E., Insp. B. & B., I. C. R., Moncton, N. B.
Large, H. M., Mast. Carp., G. R. & I. Ry., Ft. Wayne, Ind.
Larson, John, Ofs. Engr., 32 No. Clark St., Chicago.
Leake, T. S., Gen. Contractor, Chicago.
Lichty, C. A., Gen. Inspector, C. & N. W. Ry., Chicago.
Loftin, E. L., Supvr. B. & B., Q. & C. Ry., Vicksburg, Miss.
Mann, J. M., Gen. For. B. & B., F. W. & D. C. Ry., Ft. Worth, Tex.
Markley, A. S., Mast. Carp., C. & E. I. R. R., Danville, Ill.
Markley, J. H., Mast. B. & B., T. P. & W. Ry., Peoria, Ill.
McKeel, W. S., Mast. Carp., G. R. & I. Ry., Grand Rapids, Mich.
McLean, N., Mast. Carp., Erie R. R., Huntington, Ind.
McNab, A., Supvr. B. & B., P. M. R. R., Holland, Mich.
Meyers, W. F., For. B. & B., C. & N. W. Ry., Belle Plaine, Ia.
Moen, J. D., For. B. & B., C. & N. W. Ry., Boone, Ia.
Moore, W. H., Engr., Bgs., N. Y. N. H. & H. R. R., New Haven, Conn.
Mustain, B. J., Supt. W. S., E. P. & S. W. Ry., El Paso, Tex.
Noon, W. M., Supt. B. & B., D. S. S. & A. Ry., Marquette, Mich.
Nuelle, J. H., Engr. M. of W., N. Y. O. & W. Ry., Middletown, N. Y.
O'Neill, P. J., Mast. Carp., L. S. & M. S. Ry., Adrian, Mich.
Patterson, S. F., Gen. For. B. & B., B. & M. R. R., Concord, N. H.
Penwell, J. N., Supvr. B. & B., L. E. & W. R. R., Tipton, Ind.
Perkins, H. D., Danville, Ill.
Perry, W. W., Mast. Carp., P. & R. Ry., Williamsport, Pa.
Pickering, B. F., Supt. B. & B., B. & M. R. R., Salem, Mass.

POWELL, W. T., Supt. B. & B., C. & S., Ry., Denver, Colo.
RETTINGHOUSE, H., Div. Engr., C. & N. W. Ry., Boone, Ia.
RINEY, M., For. B. & B., C. & N. W. Ry., Baraboo, Wis.
ROBINSON, J. S., Div. Engr., C. & N. W. Ry., Chicago.
ROHBOCK, W. L., Asst. to Ch. Engr., W. & L. E. R. R., Cleveland.
SATTLEY, R. C., Valuation Engr., C. R. I. & P. Ry., Chicago.
SCHALL, F. E., Bridge Engr., L. V. R. R., So. Bethlehem, Pa.
SCRIBNER, C. J., Bldg. Inspr., C. B. & Q. R. R., Chicago.
SHEDD, A. R., Asst. Gen. Brg. Insp., C. & N. W. Ry., Chicago.
SHELDON, J. B., Supvr., B. & B., N. Y. N. H. & H. R. R., Providence, R. I.
STANNARD, JAS., 1602 Broadway, Kansas City, Mo.
STATEN, J. M., Gen. Insp. Brdgs., C. & O. Ry., Richmond, Va.
STORCK, E. G., Mast. Carp., P. & R. Ry., Philadelphia.
STROUSE, W. F., Asst. Engr., B. & O., R. R., Baltimore.
SWEENEY, W. M., For. B. & B., C. & N. W. Ry., Green Bay, Wis.
TANNER, S. C., Mast. Carp., B. & O. R. R., Baltimore.
TANNER, F. W., M. of W. Insp., Mo. Pac. Ry., St. Louis.
TAYLOR, F. A., Mast. Carp., B. & O. R. R., Cumberland, Md.
THOMAS, C. E., Gen. For., W. W., I. C. R. R., Chicago.
THORN, J. O., Mast. Carp., C. B. & Q. R. R., Beardstown, Ill.
WEISE, F. E., Chief Clerk, C. M. & St. P. Ry., Chicago.
WELKER, G. W., Supvr. B. & B., Sou. Ry., Alexandria, Va.
WENNER, E. R., Supvr. B. & B., L. V. R. R., Ashley, Pa.
WHITE, J. B., For. W. S., C. & N. W. Ry., Boone, Ia.
WILKINSON, J. M., Supvr. B. & B., C. N. R. R., VanWert, O.
YAPPEN, A., Dist. Carp., C. M. & St. P. Ry., Chicago.
ZOOK, D. C., Mast. Carp., Pa. Lines W., Ft. Wayne, Ind.

The following applicants for membership subsequently elected, were also present:

CASE, F. M., For. W. S., C. & N. W. Ry., Belle Plaine, Ia.
CLOPTON, A. S., Supt. B. & B., M. K. & T. Ry., Parsons, Kans.
ETTINGER, C., Gen. Ptr. For., I. C. R. R., Chicago.
JOHNSTON, C. E., Ch. Engr., K. C. S. Ry., Kansas City, Mo.
LAWRENCE, P. P., Gen. Br. For., L. E. & W. R. R., Tipton, Ind.
MURRAY, EDW., Asst. Engr. B. & B., C. M. & P. S. Ry., Miles City, Mont.
MUSGRAVE, C. T., For. B. & B., O. S. L. R. R., Idaho Falls, Idaho.
SCHNEIDER, P. E., Archt., M. C. R. R., Jackson, Mich.
SMITH, C. E., Bridge Engr., Mo. Pac. Ry., St. Louis.
SWARTZ, H. C., Mast. B. & B., G. T. Ry., St. Thomas, Ont.
TAYLOR, J. J., Supt. B. & B., K. C. S. Ry., Texarkana, Tex.
TEAFORD, J. B., Supvr. B. & B., Sou. Ry., Princeton, Ind.
VAN AUKEN, A. M., Ch. Engr., M. D. & G. R. R., Nashville, Ark.
WALLENFELSZ, JOHN, Mast. Carp., Pa. Lines W., Cambridge, O.
WARCUP, C. F., For. W. S., G. T. Ry., St. Thomas, Ont.

Total number registered, 102.

The President:—The next matter in order is the reading of the minutes of the last meeting, but inasmuch as they have been printed we will dispense with the reading as has been our custom. It will, however, be necessary that a motion be made to that effect.

On motion the reading of the minutes was dispensed with.

Next in order will be the president's address.

PRESIDENT'S ADDRESS.

We have again assembled at the birthplace of this association. When, 20 years ago, a little band of faithful members of the bridge and building craft gathered in this city to organize themselves into what they styled the American International Association of Railway Superintendents of Bridges and Buildings it was little thought at that time what proportions the newly born child would assume, how it would grow, and what important position it was destined to occupy in the railroad world. Today we can proudly look back upon our achievements, and pay tribute fitting and well earned to the founders of this association. Well may we be proud not only of the results of our investigations, our committee reports and discussions that have gone forth, in the shape of our annual publication to become a text book in bridge and building work; not only may we be proud of the personal achievements and successes of individual members; but we may, also, and not leastly, be proud of the good and harmonious feeling, the good fellowship which has ever existed and today does exist and will continue to exist in our beloved organization.

When the founders of this society met for the first time in annual convention in this city there was no contention, or dissension whatever, but we read in the proceedings of the first annual convention (and the book of proceedings is very small, only 8 pages against about 300 pages of today's proceedings) how harmoniously the business was conducted. This spirit has prevailed throughout the twenty years of existence, and the men elected by this association to conduct its affairs have been of the right stamp, and they have preserved the spirit of old. There has been always a spirit of tolerance and broad gauge good fellowship. We have not permitted political or religious discussions in or out of the convention hall. We have ever been adhering to the stout belief that the Almighty cares not whether one human being has accidentally been thrown into the bosom of this church, and another into the bosom of another church, and that God looks with a kindly eye upon him who loves his neighbor as himself; who carries out his mandates in his own fashion; who is true to his fellow beings and to himself; and who spreads the gospel of brotherly love.

Some of the old guard are still with us, and some of them are present at this convention. It is needless to say that we all extend to them the glad hand of welcome to this our home-coming day. It is a home-coming day indeed, and, personally, it is a home coming to me, as I joined the association at the convention in this city in 1900.

I want to tell you of a little incident that happened at that time, and which goes to show that even then some of the older members would be mistaken in their judgment. My wife, who, as usual, had me in tow on the morning of the first day of the convention, led me to a table in the breakfast room of the Southern hotel, where another elderly couple were already seated. We concluded from their conversation, that they belonged to the great family of convention people, but as my wife is rather timid, and I am more so, we did not at once seek to make ourselves acquainted. However, we became quite intimately acquainted with the same couple later on, and some years after were told by them that they thought we were a newly-married couple and on our wedding trip. Now, when it is considered that I was so close to 40 years as to leave but little margin (I won't tell you how old my wife was), it is doubly strange that Bro. W. O. Eggleston and his estimable wife (who were the couple in question) should display such bad judgment.

I have told you that I was timid at that time. I listened attentively to the discussions, but could not muster up enough courage to get up and take part in the proceedings. I have often noticed since that time that new members act likewise, and at their first convention they will be as silent as the tomb, and much valuable information will remain dormant. I believe it to be the duty of the presiding officer to bring our new members into the dis-

cussions, and I want, therefore, to serve fair notice on all new members that they will be called upon.

In the past most of our presidents have, in their annual addresses, given a resume of the association's history. I find that it will be a useless trespass upon your time to do so, as our able secretary has relieved me of that duty through his recent publication in the association "Bulletin," giving both the early and the late history of the association.

The reports of the secretary and treasurer will be received in regular form later, and will give you in comprehensive form all the business information desired. Suffice it, therefore, to say that our membership, from a charter list of 60, in 1891, and a membership of 143, in 1900, has steadily grown to a present membership of 500. We are, therefore, prosperous.

Death has invaded our ranks and has removed from us W. B. Wood, T. A. Causey, H. M. Henson, C. F. Spencer, also three pioneers in the bridge and building service, H. P. Morrill, Henry Crane and W. D. Walden. It is a strange and sad coincidence, that the three last named were all life members of this association and retired employés of the Chicago & Northwestern Ry. The committee on memoirs will fittingly pay tribute to the memory of these departed members. To me, personally, it has been a greater loss, as I was intimately acquainted with all three of them, and in a business way connected with one of them, the late W. D. Walden, and a grand old man and a jewel in his profession.

One thing more: I can not thank too much our secretary for his untiring efforts in behalf of this association in general, and his equally untiring efforts in my personal behalf. As many of you know, I was suddenly stricken with what nearly proved to be a fatal illness, which prevented me from attending the executive committee meeting in Chicago, in March, and which made me unfit for business for several months later, and which was only relieved through a serious operation. Brother Lichty went about and did my association work in addition to his own, and I can not thank him too much. In thanking you, therefore, for the honor which you bestowed upon me a year ago, it is but just to you to say that I have been but poorly able to fulfill my duties.

From the information on hand it appears that we have some valuable committee reports, and there is promise of valuable and interesting discussions. We want all of you to display full interest, as such will be necessary in order to make the discussions valuable, and enable us to present to the railroad world, as recommended practice, methods which have been tested out; and thereby uphold and strengthen the reputation of the American Railway Bridge and Building Association.

The President:—The next in order is the report of the committee on membership.

REPORT OF MEMBERSHIP COMMITTEE.

Salt Lake City, Oct. 15, 1911.

The membership committee sent out application blanks and circulars as has been the custom for several years. The first page of the circular gave a list of the officers and the members of the executive committee; pages two and three set forth the aims and purposes of the association, and contained the invitation for making application for membership; page four contained a list of the subjects for report and discussion to come before the St. Louis convention.

Each member of the committee worked a certain territory and the secretary rendered valuable assistance in connection with the work of the committee in writing personal letters. The personal work of individual members added greatly in making this list of 93 applicants the largest in the history of the organization, the next largest class having been presented in 1904, when 89 were added to the membership.

Our membership has grown wonderfully in the western territory during the past two years, and we are especially indebted to Mr. Rear for his personal work on the Pacific slope. He has presented the names of about 40 applicants during the past fourteen months.

The following list of applicants is presented for your consideration at this meeting:—

NEW MEMBERS.

E. E. Allard, For. B. & B., Mo. Pac. Ry., St. Louis.
F. J. Arnold, Gen. For. B. & B., D. L. & W. R. R., Scranton, Pa.
C. J. Astrue, Asst. Engr., Sou. Pac. Co., Oakland Pier, Cal.
G. E. Boyd, Supt. B. & B., D. L. & W. R. R., Scranton, Pa.
Hugh Bulger, For. B. & B., Sou. Pac. Co., Oakland Pier, Cal.
W. H. Burgess, Supvr. B. & B., Sou. Pac. Co., Stockton, Cal.
E. Cahill, Genl. For. B. & B., D. L. & W. R. R., Binghamton, N. Y.
J. T. Caldwell, For. B. & B., Sou. Pac. Co., Bakersfield, Cal.
F. M. Case, For. W. S., C. & N. W. Ry., Belle Plaine, Ia.
A. S. Clopton, Supt. B. & B., M. K. & T. Ry., Parsons, Kans.
J. F. Cullen, For. B. & B., O. S. L. R. R., Pocatello, Idaho.
Wm. C. Dale, For. W. S., O. S. L. R. R., Salt Lake City.
O. F. Dalstrom, Ch. Dftsm. Br. Dept., C. & N. W. Ry., Chicago.
Geo. Dickson, For. Brdgs., Sou. Pac. Co., Oakland, Cal.
E. M. Dolan, Bldg. Inspr., Mo. Pac. Ry. Sys., St. Louis.
H. S. Douglass, Supvr. B. & B., Sou. Ry., Charleston, S. C.
H. A. Elwell, Supvr. B. & B., C. G. W. Ry., Clarion, Ia.
C. Ettinger, Gen. Ptr. For., I. C. R. R., Chicago.
A. H. Ferdina, For. B. & B., St. L. I. M. & S. Ry., St. Louis.
J. F. Fisher, Bridge Inspr., Sou. Pac. Co., Sacramento, Cal.
Morris Fisher, Supvr. B. & B., Sou. Pac. Co., Ogden, Utah.
Oscar Forsgren, For. B. & B., O. S. L. R. R., Brigham, Utah.
Phil. Fritz, For. B. & B., Sou. Pac. Co., Los Angeles.
J. A. Givens, Asst. Div. Engr., Sou. Pac. Co., Sacramento, Cal.
C. Gnadt, Br. For., St. L. I. M. & S. Ry., Poplar Bluff, Mo.
Lon Graves, For. B. & B., St. L. I. M. & S. Ry., Monroe, La.
Peter Guisto, For. B. & B., Sou. Pac. Co., San Francisco.
N. L. Hall, Supvr. B. & B., Sou. Ry., Greensboro, N. C.
Wm. C. Harmon, Br. Inspr., Sou. Pac. Co., Bakersfield, Cal.
W. B. Harris, Div. Engr., M. & O. R. R., Murphysboro, Ill.
H. R. Hill, Asst. Supvr. B. & B., L. & N. R. R., Birmingham, Ala.
J. W. Holcomb, Supvr. B. & B., L. V. R. R., Buffalo, N. Y.
Jno. Hubley, Steel Br. For., Sou. Pac. Co., Colfax, Cal.
J. M. Hurt, For. B. & B., T. C. R. R., Nashville, Tenn.
C. A. Jensen, For. B. & B., Sou. Pac. Co., Los Angeles, Cal.
C. E. Johnston, Ch. Engr. K. C. Sou. Ry., Kansas City, Mo.
A. E. Kemp, Supvr. B. & B., L. V. R. R., Hazelton, Pa.
G. W. Kinney, Inspr. B. & B., D. & R. G. R. R., Salt Lake City.
M. R. Krutsinger, Supvr. B. & B., W. Pac. Ry., Sacramento, Cal.
W. J. Lacy, For. B. & B., St. L. I. M. & S. Ry., Poplar Bluff, Mo.
A. W. Lasher, Asst. Engr., Sou. Pac. Co., Suisun, Cal.
P. P. Lawrence, Genl. For. Brdgs., L. E. & W. R. R., Tipton, Ind.
T. J. Linehan, For. Brdgs., Sou. Pac. Co., Ventura, Cal.
Harry Lodge, For. B. & B., Sou. Pac. Co., San Francisco.
J. B. Malloy, For. B. & B., Sou. Pac. Co., San Francisco.
J. D. Mathews, Div. Engr., Sou. Pac. Co., Tucson, Ariz.
F. D. Mattos, Supt. Wood Pres. Wks., S. P. Co., W. Oakland, Cal.
C. W. McCandless, For. B. & B., Sou. Pac. Co., Ventura, Cal.
R. S. McCormick, Ch. Engr., A. C. & H. B. Ry., Sault Ste. Marie, Ont.
Danl. McGee, For. B. & B., Sou. Pac. Co., Sacramento, Cal.
Angus M. McLeod, For. B. & B., Sou. Pac. Co., Oakland, Cal.
A. McQueen, Gen. For. Brs., D. L. & W. R. R., Binghamton, N. Y.

D. A. McRae, Carp. For., C. P. R., Cranbrook, B. C.
E. S. Meloy, Asst. Engr., C. M. & St. P. Ry., Chicago.
E. C. Morrison, Div. Engr., Sou. Pac. Co., San Francisco.
Edwd. Murray, Asst. Engr., B. &. B., C. M. & P. S. Ry., Miles City, Mont.
C. T. Musgrave, For. B. & B., O S. L R. R., Idaho Falls, Idaho.
W. V. Parker, For. B. & B., Rock Island Lines, Amarillo, Tex.
P. E. Parsons, For. B. & B., O. S. L. R. R., Salt Lake City.
S. J. Powell, Div. For. B. & B., O. S. L. R. R., Ogden, Utah.
J. E. Ranney, Genl. For. B. & B., D. L. & W. R. R., Buffalo, N. Y.
A. G. Rask, Supvr. B. & B., C. St. P. M. & O. Ry., Spooner, Wis.
C. E. Redmond, Supvr. B. &. B., St. L. I. M. & S. Ry., Van Buren, Ark.
J. S. Replogle, For. B. & B., Sou. Pac. Co., Oakland, Cal.
R. W. Richardson, Asst. Engr., C. & N. W. Ry., Sioux City, Ia.
A. L. Robinson, Br. Inspr. Sou. Pac. Co., Stockton, Cal.
R. B. Robinson, Asst. Engr., O. S. L. R. R., Rupert, Idaho.
Aug. Ruge, Supvr. B. & B., C. St. P. M. & O. Ry., Mankato, Minn.
D. W. Scannell, For. B. & B., S. P. L. A. & S. L. R. R., Salt Lake City.
P. E. Schneider, Architect, M. C. R. R., Jackson, Mich.
W. W. Sheldon, For. B. & B., Sou. Pac. Co., Oakland, Cal.
Jas. Skeoch, Genl. For. B. & B., D. L. & W. R. R., Dunmore, Pa.
C. E. Smith, Br. Engr., Mo. Pac. Ry. Sys., St. Louis.
A. C. Snyder, For. B. & B., D. & R. G. R. R., Glenwood Springs, Colo.
H. Stamler, Supvr. B. & B., L. & N. R. R., Paris, Ky.
E. A. Stanley, Supvr. B. & B., Mo. Pac. Ry., St. Louis.
C. A. Stelle, Div. Engr., W. & L. E. R. R., Canton, O.
W. A. Swallow, Ch. Engr., Ga. & Fla. Ry., Augusta, Ga.
H. C. Swartz, Master B. & B., G. T. R., St. Thomas, Ont.
J. J. Taylor, Supt. B. & B., K. C. S. Ry., Texarkana, Tex.
J. B. Teaford, Supvr. B. & B., Sou. Ry., Princeton, Ind.
E. E. Templin, For. Carp., P. & R. Ry., Pottsville, Pa.
J. E. Travis, Br. For., I. C. R. R., Carbondale, Ill.
J. H. Travis, Insp. Iron Br. Erec., C. & N. W. Ry., Chicago.
A. M. Van Auken, Ch. Engr., M. D. & G. R. R., Nashville, Ark.
E. J. Vincent, For. B. & B., Sou. Pac. Co., Los Angeles.
J. Wallenfelsz, Mast. Carp., Pa. Lines W., Cambridge, O.
C. H. Walther, Supvr. B. & B., Mo. Pac. Ry., Poplar Bluff, Mo.
C. F. Warcup, For. W. S., G. T. R., St. Thomas, Ont.
Norton Ware, Br. Engr., W. Pac. Ry., San Francisco.
A. Weldon, For. B. & B., Sou. Pac. Co., Bakersfield, Cal.
B. F. Whiting, Supvr. B. & B., M. & O. R. R., Murphysboro, Ill.
J. P. Wood, For. B. & B., P. M. R. R., Edmore, Mich.

Total number of new members, 93.

Respectfully submitted,

A. H. King, *Chairman.*

The Secretary was instructed by a vote of the association to cast one ballot for the election of the applicants, making them members, whereupon they were declared as being entitled to all the rights and privileges of the association.

A recess was taken for distributing the badges and for the payment of annual dues.

The President:—Before proceeding I want to say that in order to help out matters we will ask each member on rising to mention his name, in order to aid the stenographer in his work. I will appoint Mr. Lee Jutton to act as assistant secretary during this con-

vention. I wish to announce that when we adjourn at 12 o'clock, we will go to the court house to have a group picture taken, to include ladies and visitors.

We will next have the report of the executive committee.

REPORT OF EXECUTIVE COMMITTEE.

At the close of the Denver meeting it was decided to grant a loan of $100 to Mr. H. M. Henson, to enable him to keep up his life insurance policy.

The secretary was authorized to have printed 1,200 copies of the proceedings; six hundred copies to be bound in cloth and a like number to be bound in paper covers.

The expenses of the committee on arrangements for the Denver convention were paid by the secretary from the funds of the association.

It was decided to have a meeting of the executive committee at Chicago in the month of March at a time to be announced by the president.

About thirty members met at the Congress Hotel, Chicago, March 22, 1911. Matters pertaining to the welfare of the association were discussed, but no regular business was transacted.

A business session was held at the Planters Hotel Monday evening, Oct. 18, 1911. The secretary was authorized to purchase such articles of furniture as were necessary for keeping the files and records of the association. An outline of the features of entertainment was gone over with the chairman of the committee on arrangements.

The secretary reported that the loan of $100 which had been made to Mr. Henson one year ago had been returned, after having been used to pay his life insurance premium, which was of considerable importance, for Mr. Henson died about two months later and the family were able to receive the amount due from the insurance, which might otherwise have been forfeited.

No further business appearing, the meeting was adjourned.

The President:—We will now have the reports of the secretary and of the treasurer.

REPORT OF THE SECRETARY.

It may well be said that the association is in a growing and prosperous condition. Our membership has steadily increased until we are beyond the five hundred mark. Most of the new members which have joined the association in the past two years are from the western half of the United States, which is largely due to the personal efforts of Mr. Geo. W. Rear and Mr. A. H. King.

Twelve hundred copies of our 1910 proceedings were issued, one-half in paper covers, the other half in cloth binding. There has been a growing demand for our publication from libraries, technical societies and institutions of learning, and all such institutions making application have been furnished.

Four numbers of the Bulletin were issued during the year. The secretary would urge upon all members the importance of sending in items of interest for publication.

Death has removed from our midst eight of our most worthy members. Memoirs of these deceased brothers will be published in the proceedings.

FINANCIAL.

RECEIPTS.

Balance on hand last report,	$ 435.77	
Fees and dues,	961.00	
Advertisements,	1,451.80	
Sale of books,	19.50	
Badges,	8.00	$2,876.07

EXPENDITURES.

Stationery and office supplies,	$ 9.65	
Postage,	115.14	
Printing,	840.69	
Drafting,	35.00	
Editing,	65.00	
Badges,	79.80	
Treasurer's bond,	7.50	
Stenographer,	125.00	
Committee expenses,	18.70	
Salaries,	600.00	
Expenses, Secretary Emeritus,	52.05	
Annual meeting expenses,	213.90	
Telegrams, express, etc.,	14.75	
Miscellaneous items,	15.50	$2,192.68
Balance on hand,		$ 683.39

C. A. Lichty,
Secretary.

REPORT OF THE TREASURER.

Cash on hand, last report,	$1,272.55
Interest to Jan. 1, 1911,	12.85
Cash on hand Jan. 1, 1911,	$1,285.40
Interest to July 1, 1911,	25.70
Balance on hand Oct. 19, 1911,	$1,311.10

J. P. Canty,
Treasurer.

The President:—I have just a few things that I want to say in connection with the forthcoming business. There has been a good deal of valuable time lost heretofore in our association meetings because the members wander away from the subject, and although I may make some enemies during these business meetings I want it understood that I shall not allow any digression from the subject whatever. I ask the members to aid me in enforcing this rule. It has often happened that while discussing, for instance, gasoline engines, some member would get up and before he got through he might be talking about a load of hay. There is too much time lost in this way and I believe, if the members will assist, that we

will have our business conducted more intelligently. I do not want to be understood as criticising any of my predecessors, but nevertheless you will agree with me that this rule should be enforced.

It has always been my experience that during the first day of the convention, the largest and best interest is manifested, and we want therefore, to do as much work today as possible. The executive committee discussed this matter in a short meeting last night, and among other things decided to hold a session tonight which, however, may be short, and the subject matter for that session will consist of the report of the committee on "Roofs and Roof Coverings." There will be some outside parties who will address us on the subject and that will make the meeting doubly interesting.

The President:—Next in order will be the appointment of committees. I will appoint, as a committee to audit the books of the secretary and those of the treasurer, W. O. Eggleston, J. N. Penwell, and G. Aldrich.

The committee on resolutions will be J. H. Markley, J. M. Staten and James Stannard.

The committee on selection of subjects for report and discussion for our next convention will consist of G. W. Andrews, A. S. Markley and F. E. Weise.

The Secretary:—I wish to announce that I have a number of subjects on hand which the committee may use, if they wish, in making up their list.

The President:—We will now receive the report of the committee on relief.

REPORT OF RELIEF COMMITTEE.

Joliet, Ill., Oct. 17, 1911.

To the Members of the American Railway Bridge and Building Association:

The committee on relief takes pleasure in reporting that during the past year no requests have been made for help in securing positions. A temporary loan of $100 was made to a member who was sick and out of work. This amount has since been returned to the association.

Yours truly,

ARTHUR MONTZHEIMER,

Committee.

The President:—If any one knows of a member in need of relief he will please report the matter.

The secretary will read a letter of interest to the association.

(The secretary read a letter received by him from Mr. Travis, the founder of the association.)

Everett, Wash., Oct. 5, 1911.

Mr. C. A. Lichty, Secretary Am. Ry. B. & B. Assn., Chicago,

Dear Sir:—I had hoped until the present time that I would be able to be in St. Louis to meet with you at the twenty-first anniversary of the association, but my hopes have been in vain, and I must forego the pleasure. I can assure you, however, that my heart will be with you in that meeting. It was in that beautiful city, twenty years ago, that we met to organize this grand organization. What a wonderful perspective it had in our minds! It has not disappointed us, yet the child has grown to larger proportions than I had anticipated. May we have reverence for those good, faithful souls who have passed to the beyond, and we say thanks to those of the old guard who are still with us, some of whom, no doubt, will be with you in the coming meeting. In this connection, if I remember correctly, a number of the early members no longer appear on the roll. Some of them, perhaps, were dropped for non-payment of dues. If so, it may not have been so much their fault as their misfortune. If such be living would it not be a charitable act to restore their names to the roll? It can not injure the association to do this, and it would be appreciated very much by them.

I hope, and I know, that you will have a good meeting. I wish I could be there to renew old acquaintances, and give a glad hand-shake to the new members.

My kindest regards to them all.

Most sincerely yours,

O. J. Travis.

The Secretary:—I would suggest, fellow members, that we send a telegram of greetings to Mr. Travis.

The President:—The suggestion is a good one, and I do not think it necessary to put this in the form of a motion. I am satisfied that every member will be heartily in favor of the proposition. I will appoint Mr. G. W. Andrews to formulate a telegram, and the secretary will please forward it.

The telegram which was sent to Mr. Travis read as follows:

"Greetings to the founder of this association, with regrets for his absence." (Signed by the President.)

We will next receive the report of the auditing committee.

St. Louis, Oct. 17, 1911.

To the Officers and Members of the American Railway Bridge and Building Association:

The auditing committee has carefully examined the books and accounts of the secretary and of the treasurer and find that the reports, as presented, are correct.

Respectfully submitted,

W. O. Eggleston,
J. M. Penwell,
G. Aldrich,
Committee.

The report was received and placed on file and the committee discharged.

The President:—Mr. Jutton will now read the report of the committee on Fireproofing of Timber Trestles. (See report, Subject No. 1.)

Gentlemen, you have heard the report. The subject is now open for discussion. (See discussion.)

Mr. J. H. Markley:—I move that we adjourn until two o'clock.

The President:—Before we adjourn I wish to remind you all that a group picture is to be taken at 12:30 at the east steps of the court house, just across the street from the hotel.

The meeting adjourned.

AFTERNOON SESSION.

Tuesday, October 17, 1911.

The meeting was called to order at 2 P. M. by the president.

The President:—We will continue the discussion of Fireproofing Timber Trestles.

Mr. J. H. Markley:—I wish to know why we have no advance copies of these reports at hand?

The Secretary:—I can furnish the information called for by Mr. Markley. The reports have been later than usual this year. Up to two weeks before convention time we had not sufficient copy on hand to make half a dozen pages of printed matter.

When a few of them came in I took them to the printers, but they can not always get them out on a few days' notice. We expected three of these reports this morning, but they have not yet arrived. We will have but three reports in printed form. The others we shall have to read from the original manuscript. Some of these have not been put in first class shape, but that will be accomplished before we send the copy to the printers. This has prevented us from sending out advance copies this year, as we ought to do and as we have done heretofore. It is quite a job to send the advance copies out by mail and there is no use of mailing them unless it can be done several weeks before the convention. We ought to have them out at least a month in advance. I am making this complaint now, so that future committees will perhaps get to work a little earlier in the season and get the reports out in time to have them published and sent out several weeks prior to the convention. We will then have opportunity to come to the meetings fully prepared for the discussion of the various subjects.

The President:—Has Mr. Penwell his report ready, Subject No. 2, "Derricks and Other Appliances for Handling Material in Supply Yards"?

Mr. Penwell:—This report is not complete and I would like

to offer an excuse. It has been suggested to me by other members of the committee that the subject be continued another year. We sent out 150 letters to the various railroads, all over the United States and Canada, and a few to foreign countries, from which we have received 31 replies. These replies represent 25 railroad companies, sixteen of which have no derricks or appliances whatever for handling their material in the bridge and building yards. The Illinois Central R. R. has presented a very fine plan of a yard and some derricks of their own make, and the New York, New Haven & Hartford R. R. has also some photographs of derricks and a plan of their material yard. The Boston & Maine R. R. has given some information on the subject. Two members from the Baltimore & Ohio R. R.—Mr. Andrews and Mr. Taylor—have written very interesting letters. One road has reported using an electric crane in its yard, and so on.

Ninety per cent of the letters received refer to the use of elaborate derricks for handling iron bridges in the field, which are sometimes used in the yard. We have heard from only about six railroads that have given us the real information desired in regard to the derrick that is used in the yard exclusively.

The committee has decided that if the report is to include appliances which are taken to the field that they can not properly be classed as yard derricks for they may not be on hand when needed most, as in the case of loading material for a washout or a fire. For that reason we would like to have the subject continued, so that we can get additional information and turn the report in next year. This is an important subject. We all know that considerable money is wasted in handling timber in an awkward manner, or on account of the lack of equipment with which to handle it.

The President:—If there is no objection I will take it for granted that it is the wish of the association that the subject be continued next year and that the information submitted by Mr. Penwell be received as a report of progress. I will suggest that the committee on subjects recommend a continuation of this subject for next year, and I would also advise the incoming president to continue the same committee.

We will pass to Subject No. 3, "Best Method of Numbering Bridges."

The report of the committee will be read by the assistant secretary. (See report.)

The President:—Gentlemen, the report is open for discussion. (See discussion.)

After the subject had been discussed for some time it was decided to pass it without making any specific recommendations.

The President:—We will now take up Subject No. 4, "Arrangement of Depot and Platforms for Small Towns, As to Convenience and Appearance." This report was continued from last year. Mr. Fake will please read the report. (See report and discussion.)

We will next take up the report on Subject No. 9, "Brick Veneer for Station Buildings." Mr. Gumphrey is chairman of that committee.

The Secretary:—Mr. Gumphrey has just this moment left the room. He received word that a Rock Island bridge on his territory near here, was wrecked by a derailed train and he went there at once upon receiving the information. This report has not been put in first-class shape, but it will be put in proper condition before going to the printer. In the absence of Mr. Gumphrey I will read the report, and we can then go on with the discussion.

After the discussion it was decided to discontinue the subject.

The secretary read a letter from Mr. McGonagle as follows:

Duluth, Minn., Oct. 15, 1911.

Mr. C. A. Lichty, Secy., Planters Hotel, St. Louis.

Dear Sir:—I sincerely regret that I am compelled to announce my inability to be present at the twenty-first annual meeting of our Bridge and Building Association to be held at St. Louis this month. I am just leaving for New York on important railroad business, and it appears at this time impossible for me to return in time for the meeting.

Will you kindly express to the members the disappointment that I feel in being deprived of the privilege to meet with them this year? I sincerely trust, however, that some time in the near future I may find that business conditions will permit me to meet with them again.

Wishing you a successful and profitable meeting, I am,

Very sincerely yours,

W. A. McGonagle.

The President:—Mr. McGonagle was one of the charter members of this association and we certainly regret his inability to be with us at this time.

Mr. J. H. Markley:—It is now about 5:30, and I move that we adjourn until tomorrow morning.

The President:—Pardon me but before putting your motion I wish to explain that it has been made a special order of business to take up this evening at eight o'clock, the report of the committee on roofs and roof coverings. Mr. Coburn, of the Vandalia Line, who is chairman of the committee on roof coverings for the American Railway Engineering Association, has given that subject very

close attention and he will be here on my invitation to give us a talk on that subject and take part in the discussion tonight. If you will kindly amend your motion to state that we adjourn until eight o'clock tonight, I will put the motion.

Mr. Markley:—I accept the amendment.

The Secretary:—I wish, before adjournment, to state that we are to have an informal reception after the business session tonight in order to give the members and their friends an opportunity to get better acquainted.

Meeting adjourned until 8 P. M.

EVENING SESSION.

Tuesday evening, October 17, 1911.

The meeting was called to order at 8 o'clock by President Rettinghouse. The assistant secretary read the report on Subject No. 10, "Roofs and Roof Coverings."

After this a lively discussion occupied several hours. (See discussion.)

Several of the supply men were permitted to express their views in regard to roofing materials, with the understanding that no firm name or trade marks be mentioned. The result was that the association received some good general information from several non-members, all of which is shown under the head of discussion of this subject.

The secretary stated that it would be necessary that all members who wished to see the test made on the Missouri Pacific Ry. bridge the following day should be ready promptly at 11:30. (This had reference to a bridge which had been treated with Clapp's fire-resisting paint.)

The meeting adjourned until 9:30 A. M. Wednesday, after which a social hour was spent in an informal reception in the parlors of the hotel which was enjoyed by the members, their families and visiting friends.

MORNING SESSION.

Wednesday, October 18, 1911.

Business was resumed at 9:30 A. M. with the president in the chair.

The President:—We are experiencing a great deal of anxiety

in regard to the reports which the secretary had printed, and which were to be forwarded here by express. This goes to show that we must be more prompt hereafter with our committee reports. If they are not printed and in the hands of the members before coming to the convention it does not give them an opportunity to study them. The mere reading of a report here does not bring out a full discussion, because it is difficult to grasp it so quickly, and the various points do not impress themselves upon the minds of the members as forcibly as is likely to be the case when each one can give it deliberate attention.

I hope that the incoming president will meet with better success, and I will ask every one present to appoint himself a committee of one to get all of the rest of the members lined up on this matter, so that we will have a better opportunity for the discussions next year.

The secretary advises that there is no report on Subject No. 5, Sash, Size and Kind of Glass for Roundhouses and Shops. It is very unfortunate that we have no report on this subject, because it is one in which we are all interested. I am personally interested in it and I know that a number of others are. It will be necessary, of course, to continue this subject for next year, and if the present committee will not produce results another one should be appointed.

We will take up the report which has been presented on Subject No. 8, Concrete Tank Construction.

Mr. Weise not being present, Mr. Jutton, the assistant secretary, began reading the report, which was concluded by Mr. Weise upon his return to the hall.

The President:—This report is quite complete and the committee is entitled to our thanks for the very able manner in which the subject is presented. The chairman of the committee has given a great deal of his time to its preparation and is entitled to more than ordinary credit.

Before entering upon the discussion on this subject I wish to call attention to paragraph five of our by-laws, which states that the report of the nominating committee is to be read at the first session of the second day. The assistant secretary will read the report of the committee. At the same time I wish to call attention to Section 1, of Article VII, of our constitution in which it states that "nothing in this section shall be construed to prevent any member from making nominations."

The report of the committee was read, and was as follows:

REPORT OF THE NOMINATING COMMITTEE.

To the Members of the American Railway Bridge and Building Association:

The committee on nominations begs leave to submit the following names for officers of this association for the ensuing year:

President—F. E. Schall, L. V. R. R.

First Vice-President, A. E. Killam, I. C. R. of Canada.

Second Vice-President, J. N. Penwell, L. E. & W. R. R.

Third Vice-President, L. D. Hadwen, C. M. & St. P. Ry.

Fourth Vice-President, T. J. Fullem, I. C. R. R.

For members of the Executive Committee: G. Aldrich, P. Swenson, G. W. Rear, W. F. Steffens, E. B. Ashby, W. O. Eggleston.

R. H. Reid,
J. F. Parker,
S. F. Patterson,
A. Montzheimer,
J. H. Markley,
Committee.

The President:—The report will lie over until the third day of the convention, when the election of officers will take place.

There is another matter that will have to be given preference to the discussion of the subject which is before us, which will require a short executive session of the entire association, and I therefore request that all those who are not members, including the press, retire for a short time. I will ask Mr. Penwell to guard the doors so as to admit none but members.

The executive session consisted of a discussion pertaining to matters relative to certain features of entertainment in connection with members and non-members of the supply men's association.

When the executive session was concluded the discussion of Subject No. 5 was taken up. (See discussion.)

It was decided to continue the subject another year.

AFTERNOON SESSION.

Wednesday, October 18, 1911.

Upon returning from the Missouri Pacific Ry. bridge, where was given the test of the fire-resisting paint, the members convened for continuing the discussion on the various subjects.

Mr. Thomas was called upon for the reading of his report on Subject No. 6, Best and Most Economical Pumping Engines. The report was read by the assistant secretary, whereupon Mr. Thomas stated for the committee that their report was rather one of progress, for the reason that it was not complete.

Mr. Thomas stated that some roads were engaged in making changes whereby gasoline engines were being replaced by those which use a distillate, or simply putting on an attachment to the gasoline engine, so that it can be run on oil costing 2½ to 3 cents,

instead of gasoline costing 10 to 12 cents, per gallon. (See discussion.)

It was finally voted to continue the committee.

The discussion on the subject of Fireproofing Timber Trestles was resumed. Mr. Jutton suggested that the committee be continued and be empowered to conduct a number of tests with fire-resisting paints, and like materials. After considerable discussion it was so decided.

The next report to be taken up was on Subject No. 11, Embankment Protection, which was followed by a lively discussion. (See discussion.)

The report was accepted and the committee discharged.

There was no report on Subject No. 7, Records of Bridges, Buildings and Other Structures.

The President:—We will now receive the report of the obituary committee.

REPORT OF THE OBITUARY COMMITTEE.

To the Members of the American Railway Bridge and Building Association:

Whereas, our Heavenly Father in his divine wisdom has called from our midst eight of our beloved members, several of whom were our oldest and most respected brothers, thus reminding us of the uncertainty of life and the certainty of the final summons, therefore be it

Resolved, That we deeply and sincerely mourn the loss of these faithful members: W. D. Walden, Henry Crane, H. P. Morrill, H. M. Henson, T. A. Causey, E. C. Spaulding, W. B. Wood and C. F. Spencer.

Resolved, That our secretary extend to the widows and families of these deceased brothers the sincere sympathy of the association, and that a copy of these resolutions be sent to their respective families and printed in our proceedings.

J. N. PENWELL,
Committee.

The Secretary:—I wish to announce that if any of the members have not registered we would like to have them do so before leaving the hall. Membership cards and receipts for dues can be had at this time.

The President:—Shall we take up at this time the selection of a location for our next convention?

Mr. J. H. Markley:—I think that should be deferred until tomorrow morning.

The Secretary:—I notice that Mr. J. O. Thorn, of the C. B. & Q. R. R., is with us. He has not been out to a convention for several years. He is one of the charter members of the association and all of those present should greet him.

Meeting adjourned until 9:30 Thursday A. M.

MORNING SESSION.

Thursday, October 19, 1911.

Meeting called to order at 9:30, with President Rettinghouse in the chair.

The assistant secretary read the report of the committee on subjects for the coming year.

REPORT OF COMMITTEE ON SUBJECTS.

1. *Fireproofing Timber Trestles.
2. *Derricks and Other Appliances for Handling Material in Supply Yards.
3. *Sash,—Size and Kind of Glass for Round Houses and Shops.
4. *Concrete Tank Construction.
5. *Best and Most Economical Pumping Engines.
6. *Roofs and Roof Coverings.
7. Reinforced Concrete Culvert Pipe.
8. The Construction and Maintenance of Long Pipe Lines for Locomotive Water Supply; Intakes, Pump Pits, Reservoirs, etc.
9. The Development of Turntables to meet Operating Conditions for the Modern Locomotive, showing most Improved Practice.
10. Track Scales,—Construction and Maintenance.
11. Painting of Structural Iron or Steel, for both Bridges and Buildings.
12. Relative Merits of Brick and Concrete in Railway Buildings and Platforms.

G. W. Andrews,
A. S. Markley,
F. E. Weise,
Committee.

The report of the committee on resolutions was next presented:

REPORT OF COMMITTEE ON RESOLUTIONS.

To the Members of the American Railway Bridge and Building Association:

The committee on resolutions respectfully submits the following report:

Resolved, That the thanks of the association be extended to Mr. John Gundlach, president of the city council of St. Louis, who, in the absence of the mayor, addressed the association and tendered to us a hearty welcome to the city;

To Mr. W. M. Walker, manager of the Planters Hotel, for the excellent treatment of the members and their families;

To the daily press, for their interest in reporting our meetings;

To Mr. W. M. Camp, editor of the Railway and Engineering Review, and Mr. E. T. Howson, civil engineering editor of the Railway Age-Gazette, who reported our proceedings for those journals;

To the Pullman Co., and the various railroads, for courtesies shown our members and their respective families en route to and from the convention;

To the "Cotton Belt Route," (St. L. S. W. Ry.,) for presentng a steel engraving of the Thebes bridge to members present at the convention;

*Continued from last year.

To the harbor department of the city of St. Louis, for the use of the boat Erastus Wells, for a trip on the river;

To the members of the Railway Bridge and Building Supply Men's Association for their efforts in entertaining our members and their families;

To the officers and committees, who rendered valuable time and assistance in promoting the welfare of the association in every detail.

J. H. Markley,
James Stannard,
J. M. Staten,
Committee.

The next matter of business taken up was the election of officers for the ensuing year. The assistant secretary read the list as contained in the report of the nominating committee.

Mr. Stannard moved that the rules be suspended and that the assistant secretary cast the ballot for the officers as named.

Motion carried.

The president called attention to the harmony which prevailed in the business affairs of the association which was shown when the vote was unanimous for the selection of officers and executive members, as recommended by the report of the nominating committee.

President Rettinghouse:—It now becomes my pleasure and duty, gentlemen, to induct into office my successor, whom you have just elected, and to relinquish my seat.

I want to say to the association that it has been a pleasant duty indeed, and I want to thank each and every one of you for the hearty support that has been given me; and I hope and trust that you will do as well for my successor. Mr. Schall, you will please come forward.

I am sorry that I can not hand you the insignia of my office (referring to the gavel). Some one has been thoughtless enough to take it away from here. I hope that you may receive the hearty coöperation and support of the association and that you will fill the office with honor and dignity to yourself and the association. I now introduce to you, gentlemen, Mr. F. E. Schall, our next president (Applause).

(Mr. Rettinghouse relinquished the chair, which was taken by Mr. Schall.)

President Schall:—Fellow members of the association: you have elected me president for the coming year, and I want to thank you for the compliment and the honor you have conferred upon me. It shall be my endeavor to serve you to the best of my ability. Of course, you understand the president stands alone, just like a

general would without an army. That means that we have got to work together. This organization has attained to large membership; its reports are published broadcast and are sought by other organizations, and it behooves us to bring our reports up to the highest standard. As we increase in membership, we must enlarge and improve our reports. Now that means that we must have committees, and we must have chairmen of committees,—live chairmen I mean,—men who are willing to work. We all know that we have to work for our railway companies, and it is not a hardship. This organization has members of whom every one of us can be proud. We come here with friendship and brotherly love that cannot be surpassed by any other organization, and we must all strive with that intention. Now it will be my duty to appoint the various committees. I am not well enough acquainted with all of you, to determine on which particular subject you may do the best work for this organization, but you know, and it will be a pleasure to me if you will come to me after this meeting and suggest, either yourself or some other member, who will act as a chairman or volunteer to assist in preparing the report for the next convention on any particular subject. It will be a great help to me, and it will certainly be a benefit to the organization. It will be my endeavor to get the notices out appointing the committees as early as possible, and I would recommend that the committees get to work early. Do not let the matter delay until the latter part of the spring, when you will have something else to take up your time. Let us do this work mostly during the winter months, when we come home early and have leisure time at night; and when you send out circulars and inquiries, do not let it rest at that. They are so easily shoved out of the way. Write a post card and tickle the fellow a little, and maybe he will wake up; in that way you may be able to get what you want. I thank you (Applause). Mr. Killam, will you please step forward. You have been elected first vice president for this organization for the ensuing year. Are you willing to accept the office?

(Calls for "speech.")

Mr. Killam:—Yes sir. I will say that it gives me great pleasure to accept this honor from the association of my choice. I have been in attendance at our conventions each year since 1898, and I must endorse the sentiment that prevails in regard to the kindly interest and brotherly love that is manifested among its members. There is not a religious organization in which this is more apparent. We ought, therefore, to have the willingness to assist in the

performance of any duty which may present itself. I came over to this country a total stranger, meeting with you first at Richmond, and have met with you each year since, and I have yet to learn of the first offense that has been committed, or of any want of courtesy on the part of any member, or from any member of the Supply Men's Association. Therefore, I have great satisfaction in stating at this time that I have the association at heart. It is something to look forward to from month to month, as I go about my duties in my own country, and I can assure you that there is not a week that passes but that I think of some of these good members. It makes the year shorter and we look forward to the time when we may again see the good friends that we have so often met.

I am from the north side of the line between the two countries, and I am sorry to say that our people, in their recent election, turned down the reciprocity treaty. Nevertheless, the feeling of friendship and kindness still prevails (applause). I have often wondered, in years gone by, when there was so much bickering through the newspapers, and noticeably from some of the senators in this country, why all this should be. We are one race of people, we speak the same language and all have the same object in view respecting trade and commerce, and each the betterment of his country; and why should this bickering be? But I am glad to know that throughout the country at large agitation has died out, and there is a friendly feeling throughout both countries. As for me, I will assure you that no country, no people is more loyal to the sovereign head than are our people on the other side of the line (applause); and I want to tell you the reason why—because the mother country has forgotten the little tea party that took place in Boston in the eighteenth century and now she allows us to do just as we have a mind to do. If we want to stay, we can stay, and if we want to go, we can go; but we want to stay and work out our own destiny, according as we can see; and means are provided for us without let or hindrance from the mother country. Therefore our feelings of loyalty and friendship and love of the mother country remain the same.

Another thing, when we feel that we, on the other side of the Canadian line, are backed up by 450,000,000 of people, we feel that we are quite somebody over there; but there is really no hostile feeling over there. However, we have got to look to the future and work for the best of our country's good, which I feel that all will do. Therefore, I will bid you good-bye for the present, hoping that we shall all meet again (Applause).

The President:—Mr. J. N. Penwell: you have been elected to act as second vice president for this organization during the coming year. Are you willing to accept the office?

Mr. Penwell:—Yes sir. I would not think of taking up your time now, but I want to thank the members of this organization for the kindness that you have shown me since I have been a member, and for the honor you have conferred upon me this morning. I want to tell you how strong I feel when I follow in the footsteps of Mr. Killam. I have always regarded him as one of the strong men of this association, and with him for my leader, I feel that I am a stronger man, and I feel proud to follow in his footsteps (Applause).

Mr. Hadwen and Mr. Fullem not being present, President Schall next installed Secretary Lichty, and the members called for a speech.

The Secretary:—We are now entering upon the work of another year. It is not my intention to make complaint in regard to the duties of the secretary, but I might mention a few things wherein you may all be of some assistance in carrying on the work. It should not be forgotten that the secretary works for a railroad company, much after the same fashion that most of you do. His labors for this organization, therefore, are being done during the evenings and holidays, and at times when many men are at leisure. Do not, therefore, criticise him too strongly for not getting his work done strictly on time. There is perhaps no other way in which the members may be able to assist the secretary better than by being prompt with reports, in paying dues, sending in information, etc. I have mentioned this so often during the past few years that many of you will begin to think that it is getting to be an old story and you will pass it by without giving it a thought. I do not intend to allow it to drop, however, and will keep it up in the future as persistently as ever.

Our organization is growing all the time, and we now number about five hundred. This means something when we address mail matter to all of the members, yet it is not so much of a task if the mailing list can be kept up to date, and everything kept in order. It is pretty discouraging to learn that some member "died more than a year ago" without anyone of our members making mention of it, or to find that some member has moved to another location and has not said a word concerning it.

We shall endeavor to continue the publication of the Bulletin if the members will take some active interest in the matter and

assist in furnishing news items and information of a general nature whereby we may be enabled to make the attempt worth the effort and the expense.

I wish to emphasize one more point which was referred to by the president, and that is in regard to our committee reports. We do not give the support to our committees that we should. Most of our committees depend on the chairman to do the work. That should not be so. At the same time most of the members are very slack in furnishing information for the use of the committee when called upon to do so, even though they have plenty of such information at hand. When we look upon the work which is being done by the American Railway Engineering Association, and others, and see the results which they are accomplishing, we can appreciate the effect of united effort on the part of the committees.

Let us not forget our association as soon as we return to our homes, but keep up a lively interest in the work. If we do this we will feel all the better when the year's work is done; when we can look back and see that we have accomplished something. I am of the opinion that we would all take a livelier interest if we realized the importance of our work, and knew that our proceedings go into many libraries and institutions of learning, and are being sought by many upon the outside.

It is by constant labor, efficient and united effort and aggressive methods that we will keep up this organization and produce results that are worthy of the department that we represent. The harvest will be exactly in proportion to that which we sow. Let us all make an earnest effort and say, "I will!"

The President:—Gentlemen, it is a pleasure to me to have our secretary get up and make a speech. He does that so regularly that we are used to it, but these remarks that he has just made are exceptionally well to the point. We know that the standing of an organization rises and falls very much with the efficiency of its secretary. Therefore, I think it is up to our secretary to do all he can to make this association a success, and he undoubtedly will. Let us give him all the encouragement that he needs and he will accomplish the results.

Mr. J. H. Markley:—I enjoyed the secretary's remarks and I think that we should encourage him all we can in the publication of the Bulletin. It is always newsy and gives us the kind of information that we are glad to get. We should lend him the necessary assistance and thus encourage him to continue its publication.

The President:—The next order of business, I understand, is

the selection of a place of meeting for next year. Nominations are now in order for a meeting place for the convention of 1912. I will appoint as tellers, Geo. W. Hand, R. C. Sattley and S. C. Tanner.

Mr. Andrews:—Mr. President, I desire to place in nomination a city just south of the Mason & Dixon line, a city that is old in the history of this country and one which has sent her loyal sons out through every state in the West,—the Middle West and the Far West,—and who have been strongly instrumental in the development of that territory. It is a city which can not boast of large shops and buildings, such as we have seen in this city, but it is one in which we can show you life, geniality, happy homes and the extreme courtesy that we find in all parts of this country, and one which I believe is as fully developed as any city in the Union. We can show you good railway terminals and handsome homes; we can show you the point where, out of all due deference to my good friend Killam, and the love and courtesy that he has gained from us, meaning no offense whatever,—the point at which Francis Scott Key composed the noble national song of our nation, the spot from which he saw the grand old flag floating; we can show you the exact point at which that flag was hung; we can show you courtesy in every way and we can make you happy. I therefore nominate the good old city of Baltimore.

The Secretary:—I would like to ask Mr. Andrews whether, if we go there, we can get a convention room that will not be as noisy from the outside as this one.

Mr. Andrews:—We do not have as much noise in Baltimore as they have in St. Louis; we go about our business in a quiet and orderly manner.

The Secretary:—Some of us from Chicago should be loyal enough to present that city, but we hardly know how to say the proper thing. You have not visited us in five or six years, and five or six years ago the city of Chicago was deficient in a great many respects which go to make up an ideal convention city, notably with reference to hotel accommodations. Today Chicago is second to no city, with the possible exception of New York, in her hotel accommodations. We have hotels of every size and every price, and the Chicago Association of Commerce will absolutely guarantee a standard hotel rate to this organization. Chicago, in every respect, is an ideal convention city. We have every means of entertainment, every means of having a good time at small expense. The Association of Commerce will see that we get a good, quiet, airy

convention hall and will see to it that in every way we would be taken care of to the best advantage. We extend to you a hearty invitation to meet in the City of Chicago.

Mr. Jutton read a letter from Mr. Rear which contained a very urgent invitation to hold the next convention at Los Angeles.

Mr. W. C. Frazier:—I am the only representative here from the Pacific Coast, and I want to assure the members of this association that we would be more than glad to have you come to Los Angeles. I can also assure you that we have ample facilities for taking care of you either in Los Angeles or some of the adjoining towns—some of the beach towns, such as Long Beach where my own home is located. We have a hotel there that would be admirable for a meeting of this kind and we could care for you right royally. We have a great deal to see in that country; our transportation facilities are first class, and there is no reason why we should not be well taken care of.

"Deacon" Patterson:—I had a little experience a year ago with Brother Rear on the coast and I can assure you that if we go there, there will be something doing.

Mr. Frazier:—There will be something doing every moment. if you will come out there.

Mr. O'Neill:—I rise to second the motion that we meet at Los Angeles. These meetings are about the only vacation that many of us get during the course of the year, and I do not believe there is a member of this organization who is a man of family but would very much enjoy a trip to Los Angeles; and the opportunities for getting there are good. It takes only a few days more than to go to any other city in the United States. I want to lend my feeble voice in support of holding our next meeting at Los Angeles.

The nominations for Baltimore and Chicago were duly seconded.

The President:—While the ballots are being distributed, I want to say that your chairman is not particularly interested as to where we meet, as far as he is personally concerned. I do feel, however, that in order not to make it a hardship for anyone of this organization to attend the meeting, we should not go to the end of the earth. It will hurt this organization if we hold these meetings too far off to one side.

The result of the first ballot was as follows: Baltimore 34, Los Angeles 34, Chicago 13. According to rule, Chicago was dropped, and the second ballot resulted in the choice of Baltimore, which received 49 votes.

Baltimore was thereupon declared the meeting place for the 1912, (twenty-second) convention.

Mr. Andrews:—When the first ballot was announced, I was half glad that it was a tie, but I am more glad that you have selected Baltimore. I will do all in my power to make your visit to Baltimore a pleasant and profitable one.

Mr. A. S. Markley:—I participated at one time in Mr. Andrews' hospitality at one of our conventions in Philadelphia. There was not a thing left undone. What he has once done he can do again, and I am sure it will be a pleasure for us to go to Baltimore.

Mr. Rettinghouse:—I want to call attention to the fact that this is the first time in this convention that Mr. Andrews and Mr. Markley have agreed (Laughter).

Mr. Andrews:—You want to watch us and see how well we agree outside.

Mr. J. H. Markley:—I move that we consider, at this time, the members eligible to life membership. The secretary, I believe, has a list and has some recommendations in that direction. If he is not prepared to make the report now, he might do so a little later.

The motion was seconded.

The following members were elected to life membership: C. P. Austin, J. T. Carpenter, John Forbes, A. B. Hubbard, S. F. Patterson, James Stannard and W. W. Perry.

Mr. Patterson:—I appreciate the additional honor you have bestowed upon me in electing me a life member. I am afraid I am not worthy of it, but if you think I am, all the better. I certainly have a kindly feeling for the association and every member in it.

Mr. O'Neill:—It grieves me to hear our worthy "Deacon" express a fear that he is not worthy of the honor of life membership, and I wish he would take that back.

Mr. Patterson:—All right, I'll take it back, I assure you that the "Deacon" will accept the honor gracefully.

Mr. Rettinghouse:—I now move that we adjourn to meet at Baltimore on the third Tuesday in October, 1912.

Motion carried and meeting adjourned Thursday noon, October 19, 1911.

G. K. ANDERSON,
Stenographer.

C. A. LICHTY,
Secretary.

MEMOIR.

William Davis Walden, was born June 6, 1825, at Christchurch, Hampshire, England; died, Sept. 18, 1911, at his home at Lyons, Iowa, after a short illness resulting from old age.

For nearly half a century, until 1901, Mr. Walden was superintendent of bridges and buildings of the Iowa division of the Chicago & Northwestern Ry. Since 1901 he has been superintendent of the Mississippi River bridge at Clinton, Ia., a less arduous task. His father was a contractor and builder in England, and the paternal grandfather was also a general contractor and builder of bridges. There is now in the possession of the Walden family the draft of a bridge built by Mr. Walden's grandfather in 1819, engraved on a silver vase, a relic which the family highly prizes.

Mr. Walden was reared and educated in his native land and for more than eight years was employed as a draftsman with architects and surveyors. He was clerk of the work of restoring Turnworth hall and the rebuilding of an old church at Maxwell, Dorsetshire. Mr. Walden arrived in New York in October, 1850. He was first employed by Montgomery Queen of Brook-

WILLIAM DAVIS WALDEN.

lyn, but he soon became associated with Mr. Henry Grimsteed, an architect of New York, under the firm name of Grimsteed & Walden, with office in Brooklyn, this connection continuing until August, 1855. As architects and superintendents of construction they had charge of the building of the Monteagle Hotel at Suspension Bridge, N. Y., for Charles B. Stuart, who at that time was consulting engineer of the Mississippi & Iowa Central R. R., and who, with others connected with the railroad company, had purchased land below the town of Lyons, Ia., for railway purposes, and had arranged to lay out a town which now forms a part of Clinton. Mr. Stuart called upon Mr. Walden in reference to a business block and hotel to be erected on the town site, and plans were drawn and arrangements made with the railway and Iowa Land Co. to erect the building, which was named the Iowa Central Hotel, now the Windsor Hotel, of which Mr. Walden had supervision. After its completion, he remained in Clinton and carried on business as an

architect and builder until the fall of 1859, when he went south looking for a new location. He had secured contracts and was at work on several buildings on sugar plantations south of the city of Baton Rouge, La., when the difficulty arose between the North and the South, and the parties concluded not to continue work.

After encountering some obstacles Mr. Walden returned to Clinton in 1861. Two years later, in 1863, he entered the employment of the engineering department engaged in the construction of the railway bridge crossing the main channel of the Mississippi River, which location is now owned by the Chicago & Northwestern Ry. He was also engaged in, and had charge of, the construction of various buildings erected at that time, and in 1865 he was appointed superintendent of bridges and buildings of the Iowa division, which position he held 36 years.

Mr. Walden was married in 1852 to Miss Mary Ann Bennett, also a native of Christchurch, Hampshire, England. Fourteen children were born to them, ten of whom are still living. One of his sons, W. J. Walden, is station agent at Carroll, Iowa, and another son, A. S. Walden, is a machinist in the shops at East Clinton. Until recently, another son, Henry A. Walden, was employed as chief clerk in the office of the division engineer at Boone, but he is now engaged at farming in Minnesota.

Mr. Walden was a familiar figure at many of the conventions of this association, having joined at Quebec, in 1903. He was made a life member a few years later. He was an ardent supporter of the association.

HENRY CRANE.

MEMOIR.

Henry Crane was born in Litchfield, Maine, Feb. 1, 1825; died at Janesville, Wis., July 29, 1911. He spent his early life on the little New England farm of his parents. Sept. 23, 1844, he entered the employ of Dr. L. S. Bartlett, of Kingston, N. H.

He began his railroad career in March, 1846, with the firm of Eastman, Gilmore & Co., on construction work connected with the C. & P. Ry. Later

he went with the same firm to Vermont, and was engaged on the work of the Northern Railroad until April, 1847. It was about this time that he entered the service of Amos Page, who was a contractor on the Northern Railroad. It was about the year 1851 when Mr. Page went to Chicago and contracted for some work on what is now a part of the Galena division of the Chicago and Northwestern Railway, and Mr. Crane followed him there, where he began work on the road, where he was employed during the remainder of his life, until pensioned, except for a short time in 1859-60, when he was on construction work in Texas, on the N. O. & T. Ry.

Mr. Crane was made superintendent of bridges and buildings in 1866, and his entire service with the Northwestern Line was confined within the limits of northern Illinois and eastern Wisconsin.

During Mr. Crane's long railroad career the railways of this country passed from the age of temporary construction of bridges and buildings to the most up-to-date modern construction of the present day. His career was so thoroughly interwoven with the growth of the Northwestern Ry. that he seemed to be almost a part of it. His strength of character and noble purposes all through life tell the story which kept him in one position in the same location during so many changes of officers. He was always the same, and was always found doing his duty.

Mr. Crane was married to Miss Mary Weaver, at Cary, Ill., Dec. 16, 1864, from which union were born two children, George H. Crane, of Janesville, and Mrs. Russell G. Colvin, of Everett, Wash. Mrs. Crane and these two children survive him. The funeral service was held at the residence and was conducted by Dr. Jenkin Lloyd Jones, Mr. Crane's former pastor, after which the body was transported on a special train to Milwaukee, where it was cremated.

Mr. Crane joined the American Railway Bridge and Building Association at Quebec, in 1903, and was honored by being elected to life membership.

H. P. MORRILL.

MEMOIR.

Hiram P. Morrill joined the American Railway Bridge and Building Association at its thirteenth annual convention, at Quebec, in 1903, and

was elected to life membership in 1907. He was born Sept. 10, 1842, in Canaan, Vermont, and moved to Wisconsin in 1854. He died Dec. 9, 1910, at Madison, Wis., from a complication of diseases. He was a sufferer for many years from a bronchial trouble, which was contracted from over-exposure. This was a serious handicap in the performance of his duties in later years, and finally led to his retirement at the age of about 64 years.

Mr. Morrill was for more than twenty years superintendent of bridges and buildings of a subdivision of the Madison Division of the Chicago & Northwestern Ry., extending from Milwaukee to Galena, Ill., with headquarters at Madison. He was associated with the road when it was built northward from Madison, and was intimately connected with its advancement and development until 1906, when he was retired on a pension. His quiet, unassuming manner and faithfulness to duty won for him the admiration and respect of both officers and employés of the road with which his life was so intimately connected.

In 1869 Mr. Morrill was united in marriage to Miss Emma Cadwell, of Lodi, Wis., who survives him. He also leaves a son, Fred H. Morrill, of Chicago; and a sister, Mrs. F. J. Edwards, of Milwaukee.

H. M. HENSON.

MEMOIR.

Hugh M. Henson was born at Eureka, Lyon Co., Kentucky, March 22, 1855, and died at his home in Beaumont, Texas, Feb. 5, 1911, after several months' illness, of diabetes. He received a common school education and assisted his father, who was a farmer and wood merchant, until the age of 21.

Mr. Henson began his first railroad work in April, 1876, with the contracting firm of Reed & Flannery, at Point Burnside, Ky., who were engaged on construction work with the Cincinnati Southern Ry. In 1877 he took employment with the bridge department of the Paducah & Elizabethtown Ry., which is now a part of the Illinois Central R. R., where he remained until May, 1881. He then engaged with the St. Louis, Iron Mountain & Southern Ry., in the bridge and building department, where he remained until Feb., 1882, when he accepted service with Mr. Decatur Axtell on the

construction of a portion of the Chesapeake & Ohio Ry., then known as the Richmond & Allegheny R. R.

In December, 1886, he went with the Missouri, Kansas & Texas Ry., on reconstruction work, in the vicinity of Denison, Texas. Two years later he accepted service with the Cotton Belt R. R., and continued in their employ, in the bridge and building department until May, 1892. He afterwards worked about a year with the Carter Construction Co., of St. Louis, on the construction of the Chicago, Burlington & Quincy R. R., from Old Monroe to St. Louis. He was engaged successively with the Clover Leaf, Chesapeake & Nashville (now a portion of the L. & N.), and the Denver, Enid & Gulf roads. While on the latter road he was engaged with the Bess Line Construction Co.

He held the position of superintendent of bridges and buildings on the Colorado Southern, New Orleans & Pacific Ry., in 1907-08; he was in charge of the work on the Beaumont City wharf in 1909; and in the same year was made inspector of masonry with the Santa Fe Ry., in western Texas, where he continued until the condition of his health forced him to retire a few months before his death.

March 17, 1880, Mr. Henson was married to Miss Lenora Gilbert, of Calvert, Ky., who died March 8, 1881. Ten years later he married Miss Kate McRoberts, of Fisher, Ark., who, within a year, was killed in a railroad accident on the Cotton Belt Line. He married Miss Laura B. Nickell, of Grand Rivers, Ky., June 26, 1895, who, with two children survives him —Lyman, 15 years old, and Doris, aged 13.

Mr. Henson joined the association at St. Louis in 1900, and was one of its staunch supporters. He was a member of the Masonic Order, as well as of the Odd Fellows.

T. A. CAUSEY.

MEMOIR.

T. A. Causey was born in Alton, Ill., Aug. 17, 1851, and died Dec. 21, 1910, a Sallisaw, Okla. His death resulted from pneumonia, although for

years he had suffered from heart trouble. At the time of his death he was engaged in erecting a bridge for the Kansas City Southern Ry., at Sallisaw, Okla.

Mr. Causey was a quiet man, an honorable citizen, one whom the people respected, and his death came as a shock to the community. His home was at LaCygne, Kansas. He was widely known in railroad circles, having been employed by the Kansas City, Ft. Scott & Memphis R. R. for twenty years, and for the past ten years was connected with the Kansas City Southern Ry.

He was married April 2, 1893, to Mrs. Rose Glascock, at Ft. Scott, Kans., who, with one daughter, survives him. He also leaves a sister, Mrs. J. H. Brant, in Kansas City, a brother, J. L. Causey, at Chicago, and his father, Mr. P. C. Causey, of San Jose, Cal.

Mr. Causey was a member of the Knights of Pythias lodge of Ft. Scott, and was a member of A. F. & A. M.

The funeral services were held in Kansas City, Dec. 25, 1910, conducted by the Knights of Pythias, assisted by Rev. Ambie Smith, of the Christian church, and interment took place in Forest Hill cemetery. The large attendance, and the many floral tributes, gave evidence of the love and respect of those who were in attendance at the last sad rites.

Mr. Causey was elected a member of this association at Richmond, in October, 1898.

E. C. SPAULDING.

MEMOIR.

Edmund C. Spaulding, supervisor of bridges and buildings of the Boston & Maine R. R., at St. Johnsbury, Vt.; elected a member of this association at Quebec, in 1903, died July 1, 1911, after a short illness.

Mr. Spaulding was born July 29, 1848, at Granby, Province of Quebec. His education while a boy was limited, and at the age of fifteen he began to work in a tannery, and later at harness making. After a number of years

at that vocation he went to the United States and took up carpenter work in the vicinity of Lowell and Manchester, and later at various points along Long Island Sound.

In 1879 he began his railroad career in the employ of the Baltimore & Ohio R. R., when, after a short time, his health failed and he returned to the New England Country. During the following year he took up work as a carpenter on the old Boston & Lowell R. R., when six years later he was promoted to foreman carpenter on the Passumpsic R. R. After a few years of faithful service he was made supervisor of bridges and buildings of the Passumpsic division of the Boston & Maine R. R., to which was shortly added the St. J. & L. C. R. R.

During the time that Mr. Spaulding resided at Concord, N. H., he married Miss Jennie Mitchell, who died many years ago, leaving one daughter, Jennie, who is now a teacher in the Chicago public schools. Nov. 10, 1883, he married Miss Lora Baker, of West Lebanon, N. H., who, with one son, Ora, survives him.

Mr. Spaulding was a member of the Episcopal church, and was affiliated with both the Masons and Odd Fellows. He was also connected with several railroad orders. He had a courteous and affable disposition and was kind toward all. He became efficient in the art of bridge building as well as other work which was entrusted to him in the bridge and building department of the railroad with which he was connected. In his death the railway company suffered the loss of a true and faithful employé, and the place made vacant in the home and community points to a noble career.

MEMOIR.

By C. W. Wright.

Charles F. Spencer was born at Jasper, Steuben Co., N. Y., May 23, 1868, and died April 14, 1911, at Morris Park, N. Y., after a three weeks' illness of pneumonia. The funeral services were conducted by Rev. Dickhaut, of the First Presbyterian church, Jamaica, N. Y., and interment was at Maple Grove cemetery, Richmond Hill.

He was the youngest of five sons of Milo (deceased) and Martha C. Spencer. The mother, at the age of 84, resides at Canisteo, N. Y. The three surviving brothers are Edwin, of Canisteo; and Carlisle and George, of Jasper, N. Y. The other brother, Joseph, died about three years ago, under similar circumstances, at Knoxville, Pa.

He was married March 31, 1889, at Knoxville, Pa., to Miss Hattie Hamm, who survives him. To this union was born one son, who died in infancy.

Mr. Spencer was in his early life a farmer. Later on he was engaged with the bridge department of the New York Central Lines, the constructural department of the Lackawanna Steel Co., and the United States Leather Co., of Buffalo. In 1907, he went with the Long Island R. R., as bridge inspector, and was in turn general foreman, supervisor of bridges, master carpenter and superintendent of construction, which position he held at the time of his death.

There comes a time when nearly every man needs a friend or an adviser, and Mr. Spencer was one to whom such could go and not meet with disappointment. Words are inadequate to express the true character and personality of the man. He was followed to his last resting place by a large number of railroad men of all departments, and about 300 of his own employés.

Mr. Spencer became a member of the association at the Jacksonville convention, in 1909, and after the meeting he and his wife, together with a dozen others, including the secretary and the writer, extended their trip to include Tampa, Key West, Havana, Miami, and other points.

MEMOIR.

W. B. Wood was born at Glasgow, Ky., and died at Atchison, Kansas, April 25, 1911, at the age of 36 years, after several weeks' illness of typhoid fever and other complications. Some years ago his nose was broken. This accident interfered with his breathing to such an extent that several operations were necessary, and these were made in the Missouri Pacific Hospital in St. Louis. These operations did not keep him from his work any considerable length of time, but they impaired his constitution to a noticeable extent. Pleurisy set in, and symptoms of pneumonia became apparent, and against so many odds life could not contend.

He began his railroad service in 1896, as a machine hand at Moberly, Mo., in the employ of the Wabash R. R., and in the following year became a mill hand in the car repairing department. In 1900 he was a carpenter in

W. B. WOOD.

the bridge and building department of the Missouri Pacific Ry., and then gradually worked his way up to building inspector, then to foreman, and, finally, in 1905, was made supervisor of bridges and buildings on the Omaha division, with headquarters at Atchison. This position he held at the time of his death.

Time and again, before and since his death, his associates, and the men who were under his supervision, have remarked that they never knew him to lose self-control or to appear excited. He was the same from day to day, always sympathetic and considerate of the feelings of others.

Mr. Wood was a disciplinarian, and his department never failed to deliver the results sought by his superior officers. He seems to have been a man who realized and lived up to the axiom, that more can be gained by co-

operating with men than by lashing them. He was always well poised, and quietly but firmly went about his work. In the face of perplexities common to his work he always wore a smile, although he was not given to indifference or frivolity. He was at all times a gentleman.

In 1903 he married Miss Bessie Stone, of Kansas City, who survives him, with their two children. His father resides at Independence, Mo., five sisters live in Kansas City, and a brother at Emporia, Kansas.

Mr. Wood became affiliated with this association at the Jacksonville convention, in 1909.

DANIEL ROBERTSON.

(Memoir appeared on page 26, 1910 Proceedings.)

SUBJECT NO. 1.

FIREPROOFING FOR TIMBER TRESTLES.

REPORT OF COMMITTEE

This report deals principally with the methods of preventing fires on timber trestles rather than with the methods of extinguishing the fire after it has started. The use of water barrels and such other things will not be considered here, because they do not make a bridge fireproof; they are only agencies by which the fire may be extinguished if some one gets to the bridge in time. What we want to consider herein is the manner of constructing timber trestles so that they will not ignite.

Most of the fires on bridges are started by sparks or coals from locomotives, although the source of the fire may be entirely foreign to railroad equipment. Not many bridges are destroyed by fire from outside sources, and beyond cleaning away vegetation from the vicinity of the bridge it would hardly pay to fireproof for such causes. Fire dropped from locomotives has burned many bridges and almost all such fires can be avoided by the use of a good type of fireproofing.

The question might be raised, "Does it pay to make trestles fireproof?" It is difficult to say just how much loss may result from the burning of a bridge. It will certainly be more than merely the cost of rebuilding the bridge. The greatest loss would be in case of a disastrous train wreck due to a burned bridge. If, however, the fire is discovered before a train may be wrecked, there is the delay to traffic, and the hurried rebuilding of the bridge, which costs considerably more than rebuilding under ordinary conditions.

With the primary object of protecting human lives, the Railway Commissioners of Canada require that railroads fireproof their bridges. They have issued a set of regulations, which is included in the appendix to this report, giving several methods which will be accepted by them as sufficient fire protection for timber bridges.

Timber bridges which need fireproofing most are those on high speed lines and those which may be visible to the engineman for only a short distance. The larger the bridge, the greater the need of fireproofing.

Types of fireproofing used mostly at the present time are as follows:

A. Ballasted floor pile bridges; about the same amount of ballast being placed under the tie, on the bridge, as on an embankment.
B. Metal covering on the ties.
C. Ballast covering from two to four inches thick on the ties; a wood filler being placed between the ties to support the ballast.
D. Metal covering on the caps and stringers.
E. Metal covering on the ties with two inches of ballast thereon.
F. Ordinary pile bridges built with certain kinds of treated timber.
G. Fire resisting paints:
H. Pile bridges having I-beam stringers.

The fireproof feature of ballasted floor timber trestles is not the most important reason for adopting this type of construction, and the details of such bridges can not properly be considered here, except to say that the ballast

serves as a first-class fire protection for the timber. These bridges with treated timber cost about 75 per cent more than the ordinary pile bridges.

The method of entirely covering the ties with metal is favored by many roads. It affords very good protection when the sheets are firmly attached and in good condition. If the metal used is of a poor quality and light weight, holes will soon develop and if it is not properly fastened it will soon work loose and the ends will curl up. If these things happen the covering is apt to assist ignition rather than prevent it, because the loose ends and holes will catch coals and sparks. There are many different ways of putting on this covering, the principal difference being the method of attaching the galvanized iron around the track rails. In most cases, No. 22 iron is used. To obtain the best results the metal should be securely fastened and of such a quality and weight that it will last a reasonable length of time. It should last as long as the timber in the bridge. When a good quality of No. 22 galvanized iron is used, this type costs about 75 cents per lineal foot, single track bridge.

Ballast covering over the entire deck is another type which affords good protection so long as everything is in good condition and no timber is exposed. Gravel ballast is used in most cases, although stone, slag and clay are also used to a considerable extent. The vibration will cause the ballast to bunch over the more rigid parts of the bridge, leaving some of the ties exposed. A very serious objection is that the ballast holds the moisture which causes decay in the timber. Clay affords a good protection and can be obtained in almost any locality; it is more stable under vibration than gravel, but it will hold moisture longer than the other materials. The draft of high speed trains tends to remove the ballast covering from the bridge.

The position of the filler blocks between the ties should be considered. The two extremes are.—placing the filler on the stringers and, placing it flush with top of ties. Placing the filler directly on the stringers necessitates a large amount of ballast for covering without gaining anything over a smaller amount as regards fireproofing. The decay of the timber is faster. because the contact surface between ballast and timber is larger, and the larger volume of ballast will hold more moisture. If the filler is placed flush with the top of the ties, the gravel rests on an unbroken surface and will readily move about, due to the vibration of the bridge and the draft of trains, which will leave bare spots. Probably the best way is to place the filler so that it will come about one inch below the top of the tie and then place three inches of ballast on the filler which would provide two inches of ballast above the ties. With gravel ballast such construction costs about 35 cents per lineal foot of single track bridge. Sometimes galvanized iron is placed over the guard rail in connection with the ballast covering. This adds about 15 cents per lineal foot to the cost.

Galvanized iron is placed on the tops of caps and stringers by a number of roads, the object being to protect the timber from weather as well as from fire. In this way the ties are left bare but the more important parts of the bridge are protected. It is not difficult to keep such covering in place. The metal should be of quality and weight sufficient to last as long as the timber. Using a good quality of No. 20 galvanized iron the cost is about 60 cents per lineal foot, of single track bridge.

Sometimes a covering of ballast about two inches thick is placed on the metal covering of type B. This partly overcomes some of the objections to this type, in that if some of the edges of the galvanized sheets work loose or holes develop in the metal the presence of the ballast will prevent fire. The draft caused by trains and the vibration of the bridge will cause the ballast to move about and leave bare spots as in type C. Also, the ballast will retain moisture; but this is not so serious as in type C, because the ballast does not come in contact with the timber; however, the moisture will rust the metal. The use of gravel ballast will increase the cost of type B about six cents per lineal foot.

On one road, zinc treated timber was found to be of value in resisting fire. The trestles are built in the usual way and treated timber used. This type probably adds $1.50 per lineal foot to the cost of a pile bridge and it

would not pay to use it for the one reason of fireproofing because the cheaper types would afford just as good protection.

Fire resisting paints are used to a considerable extent in the East and in Canada, with good results in most cases. If a paint exists which makes timber absolutely fireproof its employment would certainly be a first-class method of protecting bridges from fire, provided the paint would not injure the timber in any way. A double track trestle 136 feet long was painted with Clapp's Fire Resisting Paint,—the paint being applied to the top of caps and stringer and top and sides of ties and guard rails. The cost was 16⅛ cents per lineal foot, single track, or 1¼ cents per square foot of area painted. The Board of Railway Commissioners of Canada requires that if Clapp's paint is used, one coat must be applied at least every five years.

The use of I-beams for stringers reduces the probability of fire, although this can hardly be called a method of fireproofing timber trestles. Such construction costs about 20 per cent more than ordinary pile bridges.

Inspection and repairs are made more difficult by the use of types A, B, C, D and E, but with types F, G and H, accessibility to the different parts of the bridge is just as easy as for ordinary pile bridges, hence inspection and repairs are not interfered with.

Inquiries were made of all the important railroads of the United States and Canada, eighty-six in number, as to their practice of fireproofing timber trestles. Replies were received from 73, and out of these, 29 do not use any type of fireproofing.

A summary of the replies from the forty-four railroads which use one or more types, follows:

Chicago, Milwaukee & St. Paul Ry.:—Use gravel covered deck, galvanized iron covered deck and ballasted floor pile bridges. Have had good results in all cases.

Chicago Great Western R. R.:—Use ballasted floor pile bridges, and where long spans are necessary I-beams are used for stringers. Formerly used gravel covered deck but this was abandoned.

Chicago & North Western Ry.:—Use galvanized iron covered deck, but to no considerable extent. No. 16 iron is used. Have considered using a gravel covered deck.

Duluth, South Shore & Atlantic Ry.:—Use No. 24 galvanized iron on top of stringers for most bridges; also use gravel deck, filled one inch above ties, with 1 inch strip between the ties, placed "A" fashion, so as to drain to the outside.

Chicago & Alton R. R.:—Use ballasted floor pile bridges.

New York, Chicago & St. Louis Ry.:—Use sheet iron on top of stringers.

Great Northern Ry.:—Use No. 22 galvanized iron on top of ties. Formerly used gravel covering but it was discontinued.

Minneapolis, St. Paul & Sault Ste. Marie Ry.:—Use No. 28 galvanized iron on ties. Also use crushed stone covering, 5½ inches deep, 3 inches below and 2½ inches above top of ties. Prefer the galvanized iron covering and find that it is cheaper than the crushed stone deck.

Lake Shore & Michigan Southern Ry.:—Use crushed stone deck 2 to 2½ inches deep, place 3 inch strip between the ties which is flush on top with ties. Have had good results with this method. Also use ballasted floor pile bridges.

St. Louis & San Francisco R. R.:—Use No. 24 galvanized iron on stringers and caps. Also use ballasted floor pile bridges.

Northern Pacific Ry.:—Formerly used gravel covering, but this was abandoned on account of causing decay of the timber. Use No. 22 galvanized iron on stringers and caps and No. 22 galvanized iron on top of ties. Also use ballasted floor pile bridges.

Rock Island Lines:—Use ballasted floor pile bridges and gravel covered bridges. Gravel covering 3 inches thick,—1 inch below and 2 inches above top of ties; filler, 1 inch thick, between ties. Have had no fires on any of the protected bridges and intend to protect all bridges.

Missouri Pacific Ry.:—Use gravel covering. A filler 3 inches thick is placed between the ties and flush on top with ties. Gravel covering is 2 inches thick.

Illinois Central R. R.:—Use ballasted floor pile bridges. Have had good results with fire resisting paints and with zinc treated timber in pile bridges.

St. Louis Southwestern Ry.:—Use ballasted floor pile bridges and are very careful to keep vegetation and rubbish cleaned away from timber.

Chicago, Indianapolis & Louisville Ry.:—Use ballasted floor pile bridges, and have some bridges on which the stringers are covered with a heavy galvanized iron; good results in both cases.

Chicago, Burlington & Quincy R. R.:—Use No. 22 galvanized iron covering on the ties and sometimes cover this with 2 inches of gravel or cinders. Also use gravel covering 2 inches thick by placing filler 2 inches in thickness between the ties and flush on top with the ties.

Michigan Central R. R.:—Use ballasted floor pile bridges, creosoted timber, and on these bridges place No. 26 galvanized iron on top and sides of guard rail and on top of the cap where it extends out beyond the outside stringers. Also use pile bridges with I-beam stringers and are considering covering the ties on these bridges with galvanized iron, placing 2 inches of gravel on that.

Louisville & Nashville R. R.:—Use ballasted floor pile bridges with creosoted timber and on open floor pile bridges they cover the stringers and caps with No. 20 galvanized iron.

Queen & Crescent Route:—Use ballasted floor pile bridges and creosoted timber and on ordinary pile bridges they place No. 15 sheet iron on tops of stringers and caps; also use the method of placing this sheet iron on top of ties. Are considering fire walls of concrete every few hundred feet, for long trestles.

Wabash R. R.:—Use gravel covering.

Western Australian Government Railroads:—Use ballasted floor pile bridges. They find that it is very essential to keep dry grasses removed from the vicinity of bridges.

New York, New Haven & Hartford R. R.:—Cover stringers, caps and sills with galvanized iron or sheet zinc. Keep all combustible material away from bridges. On one division, previous to 1880, all timber stringers were heavily coated with lime whitewash every second year, with very good results with regard to fire prevention and timber preservation.

Boston & Albany R. R.:—Thin sheet iron is placed over tops of caps and stringers.

Delaware & Hudson R. R.:—On their Canadian lines they use Clapp's Fire Resisting Paint, complying with order of the Dominion Government.

Erie R. R.:—Cover stringers and caps with galvanized iron. Use whitewash to a small extent. Very careful to keep all vegetation cleaned away.

Lehigh Valley R. R.:—Have used galvanized iron on stringers.

Maine Central R. R.:—Recently have used Clapp's Fire Resisting Paint with such good results that it will now be used on all trestles. Keep all foreign combustible matter away from the trestles.

Boston & Maine R. R.:—Clapp's Fire Resisting Paint applied during warm weather at least once in three years to tops and sides of ties and guard rails and tops of stringers and caps. The entire right of way is kept free from all combustible material for entire length of timber bridges.

Philadelphia & Reading Ry.:—Have placed second-hand sheet iron on top of stringers with cross strips about three feet wide on top of ties, over each cap. In some cases have covered the ties with sheet iron.

Canadian Pacific Ry.:—Have whitewashed tops of stringers and caps. Have tested fire resisting paints with good results.

Baltimore & Ohio R. R.:—Have built two or three ballasted floor trestles on Southwest System. Where trestles occur on curves stringers are covered with galvanized iron. Have one bridge covered with gravel.

Mobile & Ohio R. R.:—Have ballasted floor pile bridges, which they consider the best type but are considering covering the stringers with galvanized iron or using a fire resisting paint.

Norfolk & Western Ry.:—Have one bridge covered with gravel as an experiment. They use a 2 inch filler block and 8 inches of gravel.

Cincinnati, Hamilton & Dayton Ry.:—Have used galvanized iron cover on stringers with good results.

Nashville, Chattanooga & St. Louis Ry.:—Are using ballasted floor pile bridges. On ordinary pile bridges they cover the stringers and caps with No. 22 galvanized iron.

Southern Ry.:—Are using ballasted floor pile bridges. On ordinary pile bridges they cover stringers and caps with galvanized iron.

Seaboard Air Line Ry.:—On trestles which can not be seen for a distance of 2,000 ft. in either direction, along the track, the stringers are covered with No. 20 galvanized iron. They are also using ballasted floor pile bridges.

Atchison, Topeka & Santa Fe Ry.:—Are using galvanized iron on top of stringers and caps; also have some bridges covered with gravel. Ballasted floor pile bridges with creosoted timber are used. Have tried fire resisting paints but this method has been abandoned.

Western Pacific Ry.:—Use gravel covered deck, by placing a filler block 2 inches thick between the ties. Gravel covering is 6 inches thick; the lower 4 inches being coarse gravel and the remainder fine gravel. Also have ballasted floor pile bridges.

Oregon Short Line R. R.:—Use gravel covered deck and ballasted floor pile bridges.

Houston & Texas Central R. R.:—Report poor results with fire resisting paints and with metal covering on top of ties or stringers. Are now using gravel covered deck and ballasted floor pile bridges.

Denver & Rio Grande R. R.:—Use gravel covered deck and ballasted floor pile bridges. With the gravel deck, a filler block 4 inches thick is placed between the ties and 9 inches of gravel placed on that.

Cleveland, Cincinnati, Chicago & St. Louis Ry.:—In the case of trestles on curves, stringers are covered with galvanized iron; have one bridge on which a timber filler was placed between the ties and the bridge covered with gravel.

Summary Showing the Types of Fireproofing Used on 44 Railroads.

Types Used.	No. of Roads Using.
A	6
B	2
C	3
D	5
G	4
A and D	6
A and H	1
A and C	6
A, B and D	2
A, B and C	1
A, G and F	1
A, C, and D	1
B and C	1
B, C and E	1
B and D	1
C and D	2
D and G	1

Summary of 44 Railroads, Showing Number on Which Each Type of Fireproofing is Used.

A	24
B	8
C	15
D	18
E	1
F	1
G	6
H	1

CONCLUSIONS.

Most railroads favor the ballasted floor pile bridge because it has many desirable qualities as well as being fireproof.

The protection of the timber from the weather is probably as much the reason for using type D as the fireproof feature.

Types F and H are used because with them a bridge is more permanent than the ordinary timber trestle, hence does not need so many repairs.

Types B, C, E and G are used solely to protect bridges from fire, and since type E is merely a slight modification of type B there remain only three types used exclusively for fireproofing.

As stated above, with the use of types B and C, inspection and repairs are more difficult to make than ordinarily, and this is quite important on timber structures; also when type C is used a more rigid inspection is necessary and more repairs will be needed than otherwise.

Type G is very simple and does not change the general construction of the bridge in any way. Another thing in its favor is the comparatively low cost. There is, however, some doubt as to its effectiveness, but a thorough test made under actual working conditions ought to determine whether a fire resisting paint is practicable to use for fireproofing timber trestles.

Lee Jutton,
W. H. Moore,
J. C. Nelson,
R. J. Arey,
Committee.

APPENDIX.

Extracts from some of the letters received are worthy of publication, and we submit as an appendix to the report:

J. C. Nelson, Engineer Maintenance of Way, Seaboard Air Line Railway: —During the past 25 years I have been continuously engaged in maintenance of way work, and during that time I have never seen or known of a trestle being fired, except from the top, therefore, I feel and believe that it is a waste of money to do anything toward protecting below the cap, other than to thoroughly clean the ground underneath the trestle of all foreign and vegetable matter. My preference of protection is the ballast floor creosoted timber trestles. They are not excessively expensive as to first cost; cost but little to maintain, and if the timber is well treated, the life should be from 35 to 50 years. The L. & N. R. R. have some creosoted timber, ballast deck trestles, which were built in 1876, and are still good. In 1881-2, the N. O. & N. E. R. R. completed a creosoted open deck trestle across Lake Ponchartrain near New Orleans, and Mr. Haugh, resident engineer of that road, told me a few months ago, that it is in perfect state of preservation, therefore, there seems to be no doubt but that ballast deck trestles built of creosoted timber, if properly treated, will last an indefinite length of time, and will effectually prevent fire. It was stated at the last meeting of the American Railway Engineering Association by the representative of some road, (I think Illinois Central) that they had experienced a fire on a ballast floor trestle, but when the gentleman was questioned it was discovered that the fire originated in a piece of open deck trestle adjoining the ballast deck, and that the fire was thus communicated to the ballast deck. I also heard of a case of fire on the Q. & C. Ry., of a ballast deck, but I investigated it and found that this was a similar case to the one above mentioned, and which in my opinion only confirms my belief and personal experience, which is that ballast floor trestles will and do effectually eliminate fires.

As to galvanized iron covering for stringers and caps: I believe that this method is a very good one, not only as a fire protection, but also as a protector of timber from decay. When the Cincinnati Southern Ry. was built, in the seventies, white pine stringers were put in a large number of trestles and all of them were fully protected with galvanized iron. In 1903, I examined some of these stringers so protected which were placed in the structures about the year 1879, and they were in good condition; in fact, many of them were so sound and clear that they were turned over to the motive power department and were sawed up for making casting patterns.

As for placing a floor between the ties and covering over with gravel or other material: I would recommend this plan, except in cases where a creosoted timber open deck trestle was in existence and in good condition. The N. O. & N. E. R. R. Lake Ponchartrain trestle is so fixed, but Mr. Haugh tells me that it is very difficult to keep the ties completely coated with the thin layer of gravel. The jar of passing trains uncovers the ties, which are to some extent liable to catch fire, and the cost of this method would be about as expensive as a regular ballast deck. For untreated timber open deck trestles, I do not think it at all permissible on account of injury to the timber, and cost of removing and replacing when renewing timbers.

I have had no experience with paint protection, nor do I know of any one that has. There are one or two paint manufacturers who make great claims for the fire resisting qualities of their paint, and they claim it is being largely used on roads in Canada and also by the New England roads. In fairness to these manufacturers, I feel that the matter is well worth investigating, as it can in a few years' time be easily demonstrated whether their paints will do what they claim.

In conclusion, I feel that the best and most effective, and in the long run the most economical method, is the creosoted timber ballast floors; and next to that, galvanized iron covering for stringers and caps.

C. F. Loweth, Chief Engineer, C. M. & St. P. Ry.:—All of the timber bridge floors on the C. M. & P. S. Ry. are fireproofed, either by being covered with sheet metal or with gravel. Sheet metal covering costs almost twice as much as the gravel covering. Both are about equally efficient, and I should say, approximately two-thirds or three-fourths of the bridges are covered with gravel, against the balance covered with sheet metal.

On the C. M. & St. P. Ry. we covered last year about ten miles of pile timber bridges according to the same plan, and about half and half.

We intend to cover at least five miles more this coming year, and will probably continue this protection in subsequent years until all timber floor bridges are protected.

We are picking out for attention first, those bridges where the speed is the greatest, and where fire would be the least likely to be seen by enginemen or by others.

We have, with few exceptions, not covered the timber floors on steel bridges for the reason that there are only the ties to burn and the floor is more open with less liability of cinders lodging.

We are using very extensively ballast floor bridges, having built over three miles of ballast floors on bridges last year on the St. Paul Lines, to say nothing about a couple of miles on the Puget Sound Line.

These ballast floors are in the form of concrete trestles and concrete slabs on steel girders, the ballast being contained in the slabs. We are also using, but to a limited extent, creosoted timber ballast floor pile bridges. We built a number of bridges of this type, although our present practice is not to use it as extensively as the others.

W. C. Smith, Chief Engr. M. of W., Nor. Pac. Ry.:—We have tried various plans along our system. Some years ago fire trouble became so bad that as a temporary expedient we stopped up the spaces between the ties on our timber bridges with fence boards and covered the deck with several inches of gravel or crushed rock. This served as a very efficient protection, but on account of the draft caused by the trains, it was necessary to frequently replace the covering.

We found, after a couple of years, that the mud deck, so-called, was hastening the decay of the superstructure of the bridges, and we decided to abandon the gravel covering and substitute galvanized iron. We placed this simply inside of the rails on some bridges, and on other districts where the fire trouble was greatest, entirely covered the surface of the bridge tops with the iron. This has proven very efficient.

We are still using the galvanized iron protection as a standard on the divisions where we burn Red Lodge coal. On some of the other divisions or on districts where fire trouble is not excessive, we simply cover the top of

the caps and stringers with the iron. This latter method, we have found, prolongs the life of the timber probably 25 per cent.

We have also a plan of a ballasted deck bridge, a few of which we have built. These have proven very efficient. The principal objection to this construction, however, is the cost of repair work, and for that reason alone we have but very few of this type. It is quite likely we will go back to the ballasted deck bridge for a number of our divisions, especially when we begin the use of treated timber for the superstructure, which use we will probably adopt in the not distant future.

A. F. Robinson, Bridge Engineer, A. T. & S. F. Ry. System:—I have tried a good many fire resisting paints on experimental bents built of creosoted material. We have found several paints which actually protected the timber work, but we found that the piling and timber had charred clear through the paint protection, so that the material would have to be repainted one, two or three coats, in order to further protect the structure. On this account we abandoned the scheme of protecting our bents with a fireproofing paint. We figure that it will cost considerably less money to keep the vegetation thoroughly cleaned from the right of way underneath the timber structures.

For a good many years we have covered the tops of our caps and stringers with galvanized iron. This has, to quite an extent, proven to be a failure, because of the wretched excuse we were able to obtain for galvanized iron. I have taken out galvanized metal sheets which had not been in service nine months and which were completely full of holes, the galvanizing having almost disappeared. The placing of sheet metal on top of the ties does not give a protection for the piling, sway bracing and under side of stringers from fire coming from vegetation on the ground underneath the bridge. This sheet metal laid on top of the ties gives us a terribly noisy structure. The maintenance of bridges fixed in this manner is expensive. I would not care to consider a scheme of this kind; it will not pay.

In regard to placing a timber floor on the ties and then covering this with a coat of gravel or crushed stone; we tried these skeleton decks in several places on the line two years ago. They protected fairly well from fire falling from passing trains, but did not give us a protection for the piling and stringers from fire that may catch on the right of way beneath the structure. I consider this a poor excuse. The maintenance is also rather expensive.

The creosoted ballasted deck pile bridge such as we have been using for years on the road gives us ample protection from fire that may fall from passing trains. It does not, however, protect the bridge in case of burning vegetation on right of way. We might try protecting the bents and lower surfaces of the stringers by the fireproof paint referred to in the first question, but we would have to count on repainting the timber work after every fire.

A. Montzheimer, Ch. Engineer, E. J. & E. Ry.:—We have never adopted any extensive plans for protecting wooden bridges from fire. As a matter of fact, we have very few wooden bridges and they are being replaced with permanent work very fast, so that in four or five years there will be no wooden bridges with the exception of the few on side tracks.

We have put water barrels on our wooden bridges and section men are instructed to keep them filled with water.

We have never used any ballasted floor on timber bridges. I have had some experience with a scheme of protecting wooden bridge stringers with galvanized steel plates, but I do not think it an unqualified success as the steel rusts very fast and it is very hard to properly test stringers with these plates on a bridge. The ballasted floor on a wooden bridge goes a long ways towards making a bridge fireproof, and in cases of important wooden bridges where it is not practicable to use ballasted floor I think I-beam stringers should be put in.

F. L. Thompson, Engr. B. & B., Illinois Central R. R.:—The percentage of fire loss on ballast floor trestles is very small, most of which is traced to incendiary origin or other foreign causes. Fire losses on open deck trestles, however, are exceedingly large on account of their exposure to coals from engine ash pans. To overcome this loss, we have tested several so-called

fireproof paints, including paints from the Clapp Fire Resisting Paint Company of Bridgeport, Conn.; also paints from the Carbolineum Wood Preserving Company of Milwaukee, Wis., with fair results.

We have used zinc treated material in quite a number of cases for open deck bridges and have found this material to be very hard to set on fire. We can get stringers, which have considerable sap and give them the zinc treatment at a cost not exceeding the cost of good live stringers and the life is about the same.

R. H. Reid, Supervisor of Bridges, L. S. & M. S. Ry.:—About the only fire protection we have in use on trestle bridges is the placing of 4 x 3 inch wooden strips about 8 ft. 8 inches long between the ties and flush with the top of the ties, getting the ends of the strips in close between the ribbon, or guard timbers as they are sometimes called, at the sides of the trestle.

Our standard ties on trestle bridges are 8 x 8 yellow pine, 10 ft. long spaced 4 in. apart, and with ribbon along the ends of the ties framed 2 in down on the ties to keep the ties in line and in place. These fire protection strips are then placed between the ties with the ends between ribbon and supported on two short blocks on each of the stringers.

This deck is then covered with fine crushed stone to a depth of about 2 or 2½ inches all the way across which prevents hot coals from reaching the timber. This has been very effective and we have had no trouble from fire where this method has been used. It is somewhat expensive, however, so we do not use it on all trestles, but on the more important ones, only where there is especial danger from fire.

In regard to ballast floor trestle, we have only one structure of this kind on our line, which was built last winter in one of our terminal yards, consisting of pile bents with caps and 8x16 stringers laid tightly together, all timber and piles being creosoted, and about 12 in. ballast on top of the stringers, forming the roadbed for the track ties.

On account of the very recent construction of this bridge, I am unable to give you any information as to its merits.

B. S. Hinckley, Engineer of Tests, N. Y. N. H. & H. R. R.:—In regard to the fire resisting properties of different kinds of timber, treated and untreated, I wish to advise as follows:

Laboratory tests were made on 6 x 6 x ¼ in. and 4 x 4 x ¼ in. slabs, and on 6 x 6 x 4 in. blocks. The slabs were tested by impinging a flame of standard size upon them, and the blocks by subjecting them to the action of live cinders.

Service tests were made on ties in the roadbed by "pulling" the fire of a locomotive and by igniting definite amounts of oil-soaked waste on the ties.

Conclusions drawn are that creosoted ties, without question, ignite more readily than untreated ties, burn more fiercely and possibly longer, but the effects are not nearly so detrimental. That is, the wood of creosoted ties is protected by a film of carbon or soot formed in the burning of the creosote, while on untreated wood the fire works in farther.

Rating shows creosoted ties first, untreated oak ties second, and untreated chestnut ties last, in order of fire-resisting qualities.

In regard to fire-resisting paints for the protection of bridge timbers and roofs, the Clapp paint proved the most satisfactory of some four or five different brands tested. The tests were severe and really did prove the efficiency of the Clapp paint.

J. B. Sheldon, Supvr. B. & B., N. Y. N. H. & H. R. R.:—On trestles, probably the best fire protection is afforded by a solid ballast floor,—first thoroughly cleaning all rubbish, grasses, weeds, etc., away from the piles at the ground. However, the ballast floor is expensive and in most places would probably not be warranted.

We have, in years past, used heavy galvanized iron on top of the stringers. This makes very good protection against fire but unless the iron is very heavy the ties will soon chafe it through and it will rust out.

From 1851-1855, the Hartford, Providence and Fishkill Railroad built a line from Providence to Waterbury, Ct., some 120 miles in length. On this

line, all frame bridge structures of truss and trestle pattern were heavily coated every second year with quicklime or common whitewash. This practice was followed for a period of about twenty-five years after erection and the losses from fire were very small. About 1880 this practice was discontinued and the results were marked increases in loss by fire. Further, the state of preservation of these structures was remarkably good, some of the Howe trusses being in actual use for more than fifty years, during which period they called for very little renewal of timber. A part of this time, however, they were reasonably well protected from the weather by housing.

From our experience and observations, we think that if all frame bridge structures were heavily coated with a lime-wash every two or three years, fire risks would be greatly reduced, while the expense would not be large.

In addition, we think that a liberal application of lime-wash is one of the best wood preservatives we have, possibly excepting creosote oils and a few other pressure-processes of preservation.

E. T. Jeans, Supt. B. & B., H. & T. C. R. R.:—I have experimented several times with so-called fireproof paint but so far have failed to find one deserving the title. Was present at a demonstration of a fireproof paint in which it was necessary to put out the fire with water to save the structure. Could see very little if any effect, due to the paint.

In my experience the use of sheet metal on top of the ties or on top of stringers has not been satisfactory. The metal protects the timber from the fire, but it allows a dry rot to form directly under the metal. It has proved of advantage in protecting the timber floors on metal bridges, as it allows rain water to get away quicker than a ballast floor, unless the ballast floor is constructed with more than ordinary care.

On this road we still have a few open deck timber trestles, and several of these have been fireproofed by building a floor of one inch lumber between the ties and then filling between the timber guard rails with gravel to a height of about one-half the height of the rail. This has proved effective as a fire preventative, as we have had no trouble from fire with any of the trestles so treated. Several of these bridges have required attention on account of using too fine a quality of gravel which sifted through the cracks in the floor. This made it necessary to renew the gravel covering. Such renewal could be prevented by using a coarse gravel, or by taking more care in the construction of the false floor.

Our standard trestle is the ballast deck. It is being used to replace all open deck structures as they require renewal. This ballast deck trestle has fifteen inches of gravel under the base of rail.

We impress it upon the section foremen that they must keep all wood and grass cleared from under timber trestles. When it is noticed that an engine is dropping fire it is immediately reported and an investigation made for defects in ash pans. All engines are inspected when arriving at roundhouse to determine condition of ash pan.

The Board of Railway Commissioners for Canada:—In pursuance of the powers conferred upon it by Sections 30 and 269 of the Railway Act, and of all other powers possessed by the Board in that behalf; and upon hearing what was alleged at the sittings of the Board held in Ottawa on the 8th day of June, 1909, by Counsel and representatives for the Canadian Northern, the Grand Trunk, and the Canadian Pacific Railway Companies, and the Michigan Central Railroad Company;

It is ordered and directed,

1. That every railway company subject to the legislative authority of the Parliament of Canada operating by steam power any railway or railways, any part or parts of which is or are constructed of, or upon, wooden trestles, the whole of which can not be seen from an approaching train for a distance of at least one thousand feet, do, during the months of May, June, July, August, September and October of each year, provide, place and keep a watchman, track-walker, fire alarm signals, ballast flooring, zinc covering over caps and intersections, or approved fireproof paint, as hereinafter directed, for the purpose of protecting the said trestles from fire; each such company having the option of adopting any of the said foregoing methods of protection.

2. That every such company shall cause to be placed and maintained at every trestle less than thirty feet in length, one barrel of a capacity of at least forty-five gallons, and on trestles of over thirty feet in length a like barrel upon or near each end, with intermediate barrels of the like capacity not more than one hundred and fifty feet apart: Provided however, that pile trestles over streams or other bodies of water need not be furnished with intermediate barrels.

3. That every such company shall cause the said barrels to be kept filled with water.

4. That every such company shall cause all brush and dead grass to be removed from beneath and around every such trestle, and shall cause its right of way crossed by such trestle to be kept free from combustible matter.

5. That, on or in the neighborhood of timber lands, or in localities distant from settlement, every such company shall cause to be provided pails for use at all trestles, and all watchmen and track-walkers shall carry such pails while upon duty at trestles.

6. That where the protection provided is by watchman or track-walker all trestles on main lines shall be inspected at least twice each twenty-four hours, at intervals of not less than eight hours, and once every twenty-four hours on branch lines.

7. That in the event of any such barrel or pail not being in good and efficient condition for holding water every such watchman or track-walker shall forthwith repair or replace the same or if it can not be done by him, he shall forthwith report such condition to his superior officer. Every such watchman or track-walker shall see that water barrels are all times kept filled to within ten inches of the top, or forthwith report same to his superior officer. Every such watchman or track-walker, whenever any such trestle is injured by fire, shall, as soon as possible thereafter, report the same to his superior officer.

8. That the fire alarm signals be equal, in the opinion of an Engineer of the Board, to the Montauk Thermostat.

9. That if fireproof paint is used, one coat thereof, at least equal to the Clapp Fireproof Paint, be applied at least every five years.

10. That the ballast flooring be of gravel and be at least equal to the standard of the flooring adopted by the Great Northern Railway Company, plans of which are on file with the Board under file No. 4966, case 1860. This flooring consists in a complete coating of gravel from beneath the head of the rail to the ties, and extends laterally from outside guardrail to outside guardrail.

11. That if zinc or galvanized iron is used, the caps, stringers, and the outside of the batter posts of every such trestle, and, if the company desires, the ties, be covered with a zinc or galvanized iron covering.

12. That every such railway company failing or neglecting to comply with any of the foregoing regulations, shall be subject to a penalty of thirty dollars.

13. That every such watchman or track-walker failing or neglecting to make inspection in accordance with the foregoing regulations, or failing or neglecting to make any of the reports herein required of him, or otherwise defaulting in any of the duties imposed upon him by this order, shall be subject to a penalty of fifteen dollars for each such failure or neglect.

14. That every such railway company shall cause every such watchman or track-walker to be furnished with a copy of this order.

15. That the Order of the Board No. 5103, dated July 30th, 1908, be, and it is hereby rescinded.

J. P. Mabee,
Chief Commissioner Board of
Railway Commissioners for Canada.

F. E. Schall, Bridge Engineer, L. V. R. R.:—This Company has not as a general rule used any protection from fire on timber trestles. We have, however, used galvanized sheet iron as a hood over the stringers; this method has been effective as far as fire protection is concerned.

We have on this road very few large trestles; for that reason the question of fire protection has not been actively considered. In my judgment a good method would be to place a 1¼ in. tongued and groved sheeting on top of the ties the full width between outside guardrails, and cover this with galvanized sheet iron; this would protect the entire deck against fire, but would be rather expensive for small trestles, but for large expensive trestles this should prove satisfactory.

Arthur Ridgway, Asst. Chief Engineer, D. & R. G. R. R.:—We have never considered the use of fire resisting paint or other liquid coating for the protection of wooden trestles against damage or loss by fire.

It has never been the practice of this company to guard against fire losses in wooden trestles by the use of sheet metal on top of ties, caps or stringers.

We have protected the greater portion of our wooden trestles by a form of construction, which we term "fire decking," and are rapidly treating the remainder in a similar manner. This is accomplished by placing wooden strips between the ties and covering the entire exposed surface of the deck, except the guard rail, with broken stone or crushed slag ballast. We have tried a number of forms of construction for this purpose, and are now adopting a style that owing to the simplicity of installation, will prove much more economical than other designs.

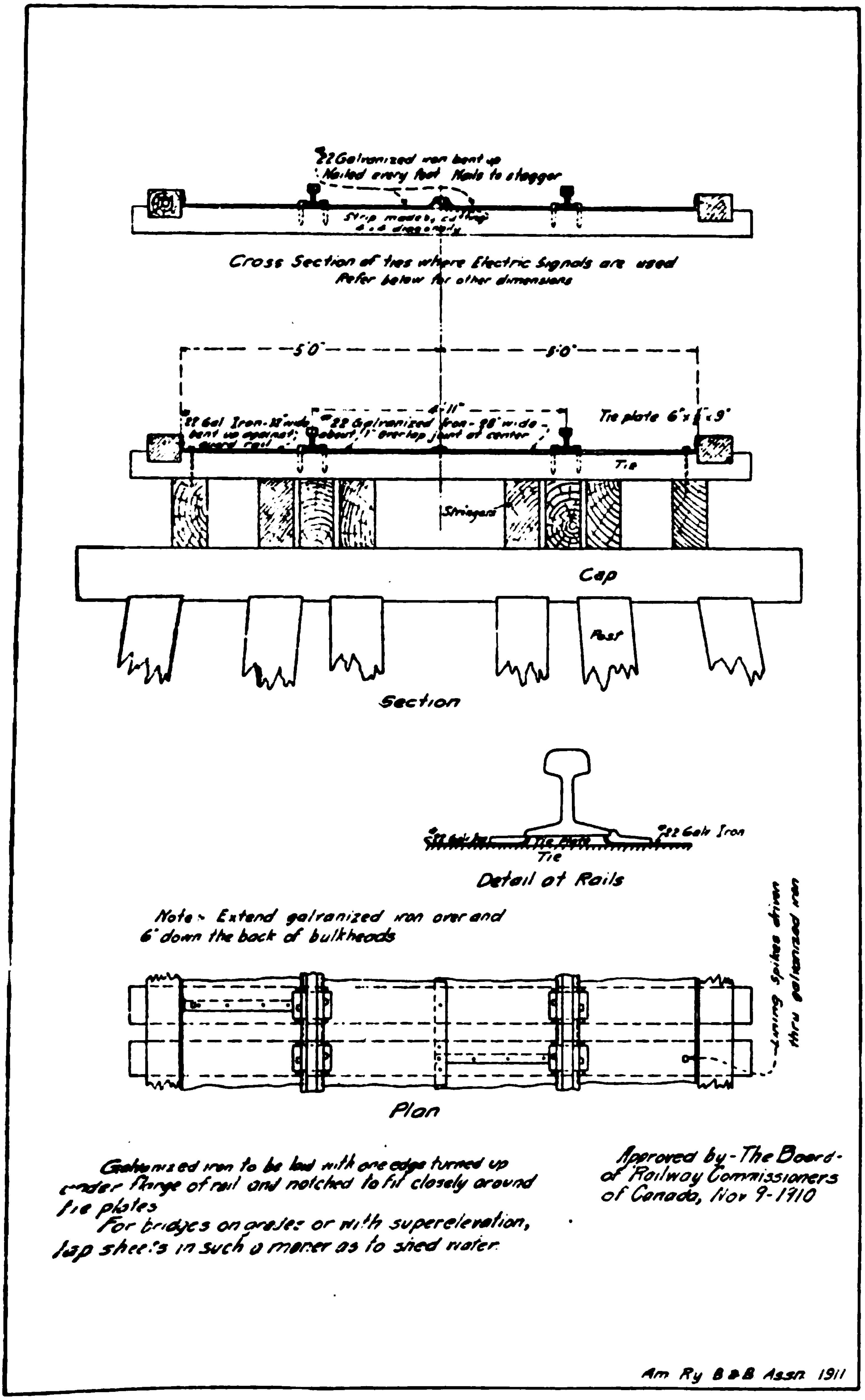
We consider that a full ballast floor pile or frame trestle will practically serve as an efficient protection against loss and damage by fire. Our standard form of construction for full ballast deck trestles, a number of panels of which have been installed for trial, has proven eminently satisfactory and serviceable. While we have never extensively renewed our bridges so as to secure this full ballast deck, yet we feel that in view of our standard plan for open floor trestle, this type of ballast deck is most economical and serviceable for our purpose. Bridges constructed in accordance with this design can easily be maintained, both as to superstructure and pile sub-structure. Our standard open floor trestle can be easily altered, so as to allow the full ballast deck construction.

W. F. Steffens, Engineer of Structures, B. & A. R. R.:—In my own practice, I have always specified thin sheet iron placed over the tops of caps and stringers, as the best possible means of protecting the timber from, not only cinders dropping from the locomotives, but also excluding water, and thus preventing decay.

Other than this, the best methods of protection from fire on trestles can be obtained by converting these structures into ballast floors, as is done extensively by the Western railroads.

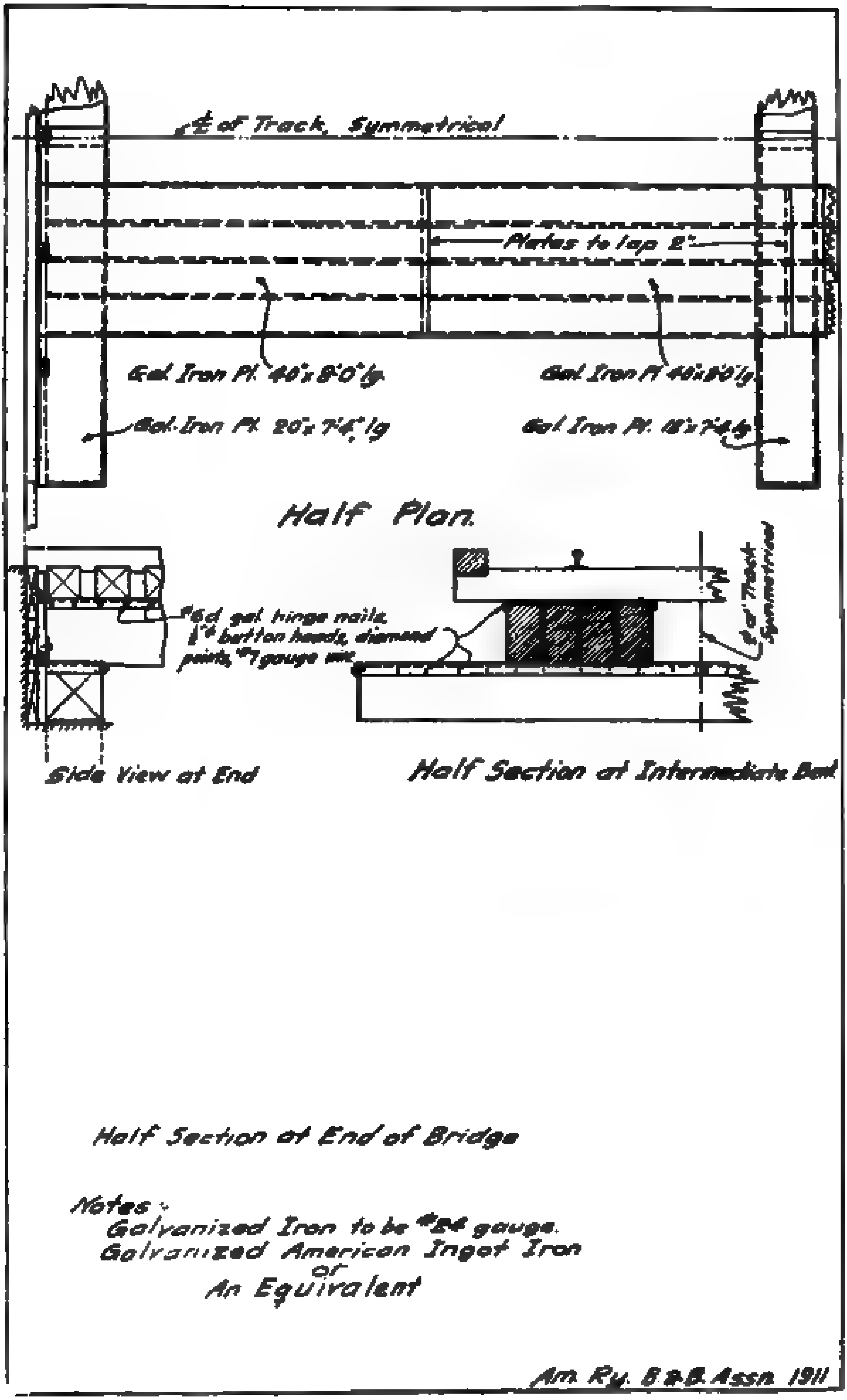
Walter H. Norris, Bridge Engineer, Maine Central R. R.:—In regard to methods used for protection of wooden trestles, I will say that until recently the Maine Central Railroad has used no method to protect its wooden trestles from fire, except to keep the trestles cleared of combustible matter, and the ground near it free from vegetation. It has also maintained barrels filled with water at each end of the bridge as well as at intermediate points on long bridges.

About two years ago, we began to treat trestles with Clapp's fire resisting paint, and are so well satisfied with the results that we are going to use it on all of our trestles. One bridge that bothered us frequently (at least every month) by catching fire from sparks and hot ashes from passing locomotives, was treated with fire resisting paint. The tops and sides of the ties, stringers and caps, and posts were given one coat last summer and we have had no trouble since.



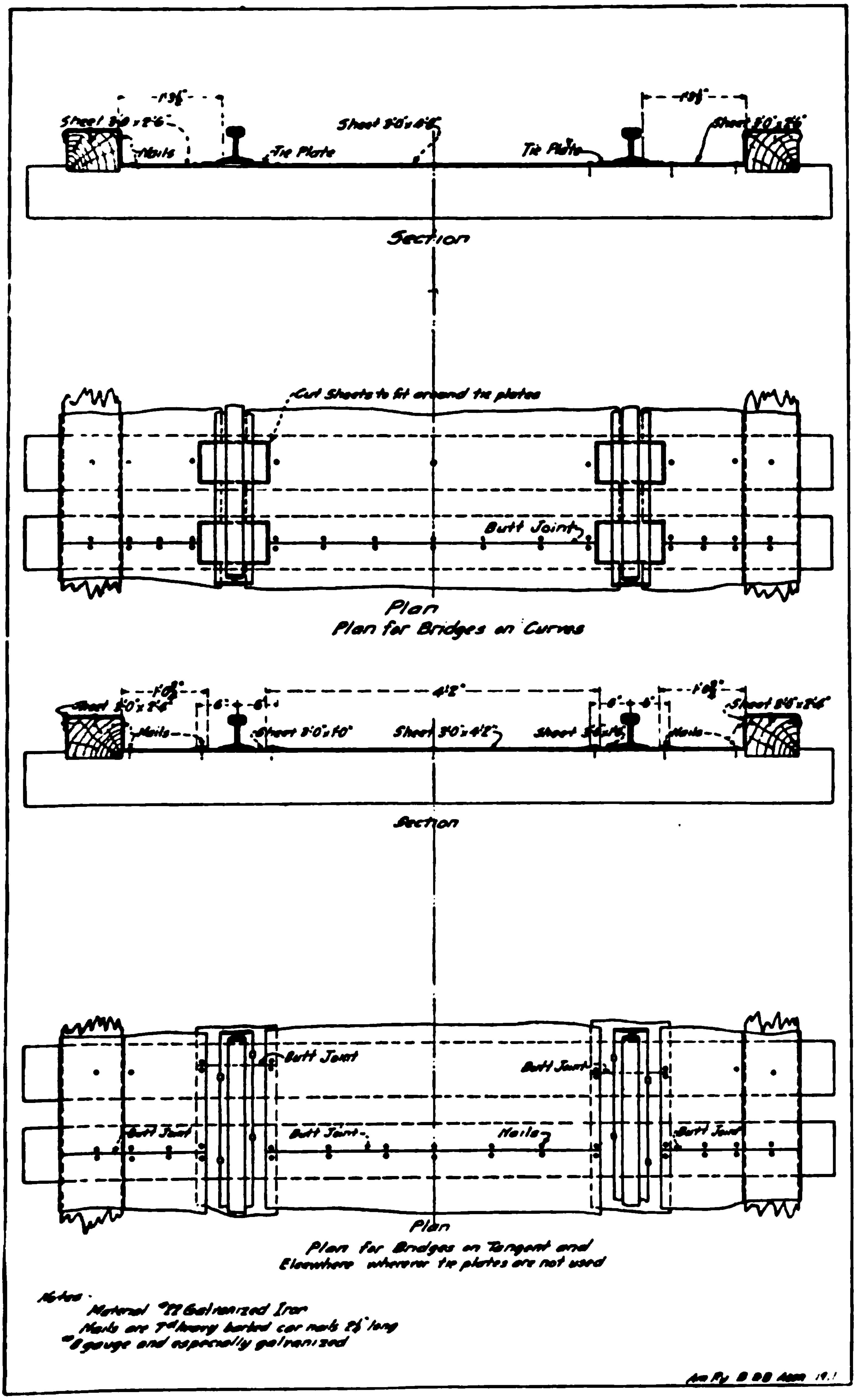
Fireproofing for Timber Trestles.

Great Northern Ry.



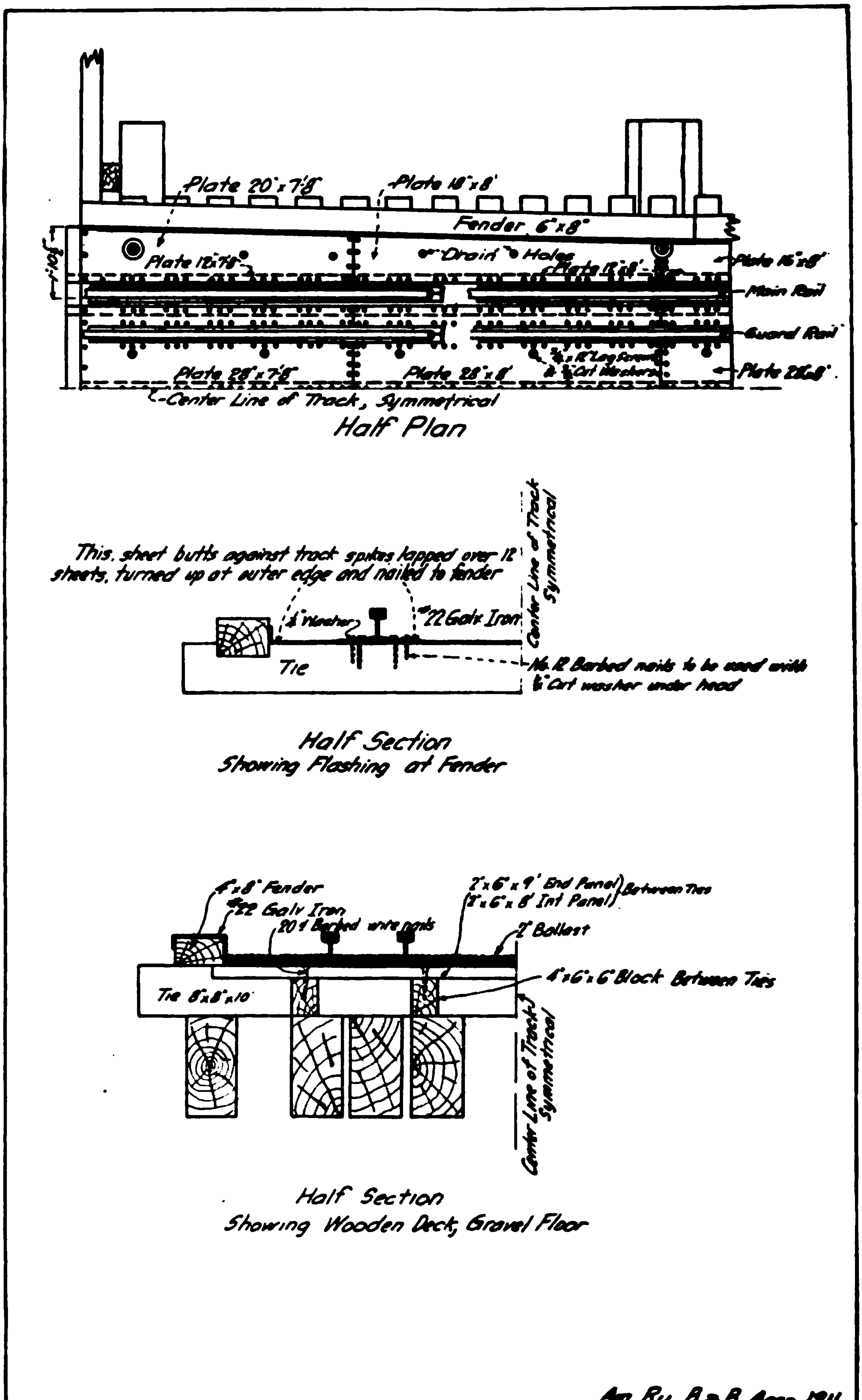
Fireproofing for Timber Trestles.

Frisco Lines.



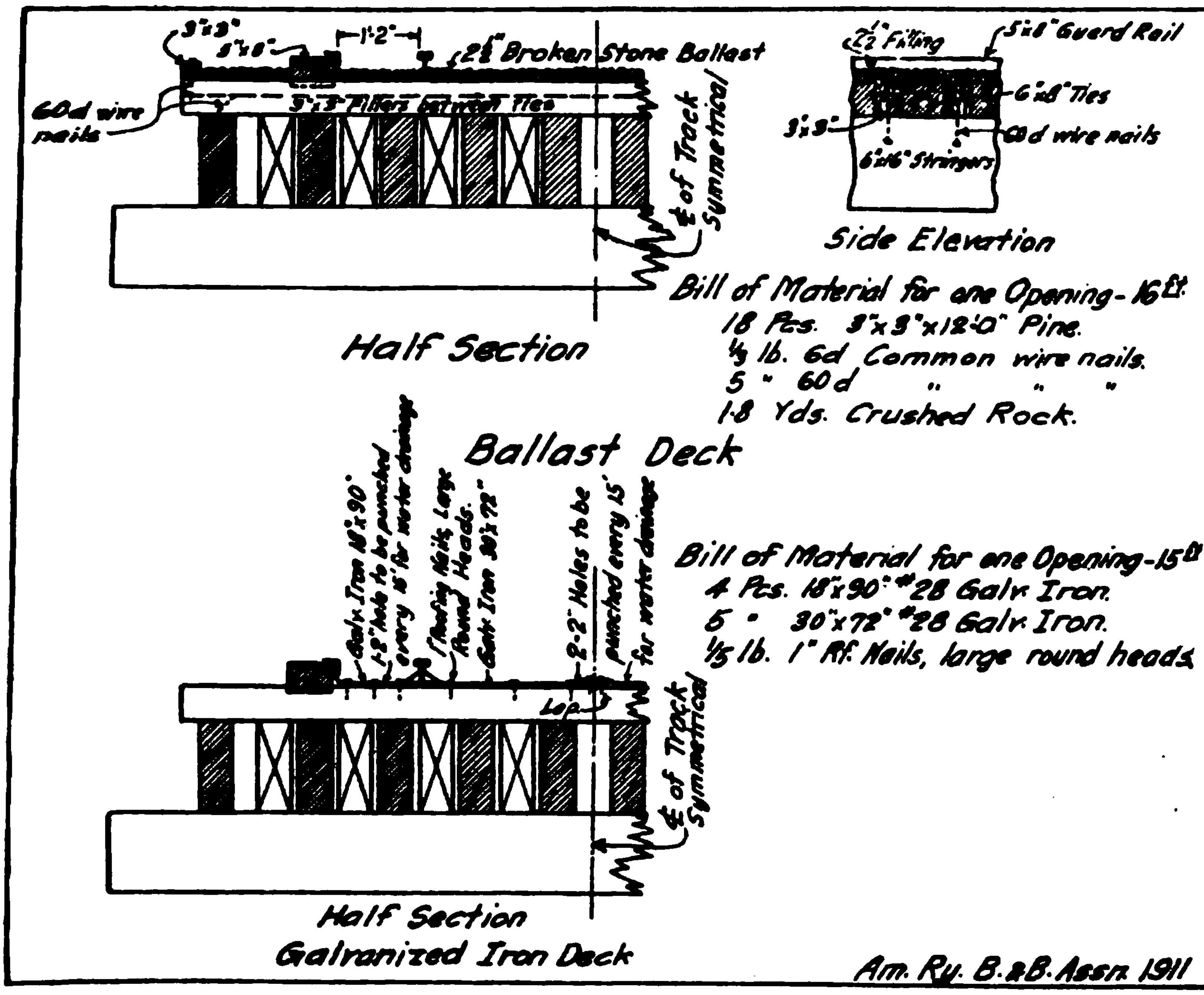
Fireproofing for Timber Trestles.

Chicago, Milwaukee & St. Paul Ry.

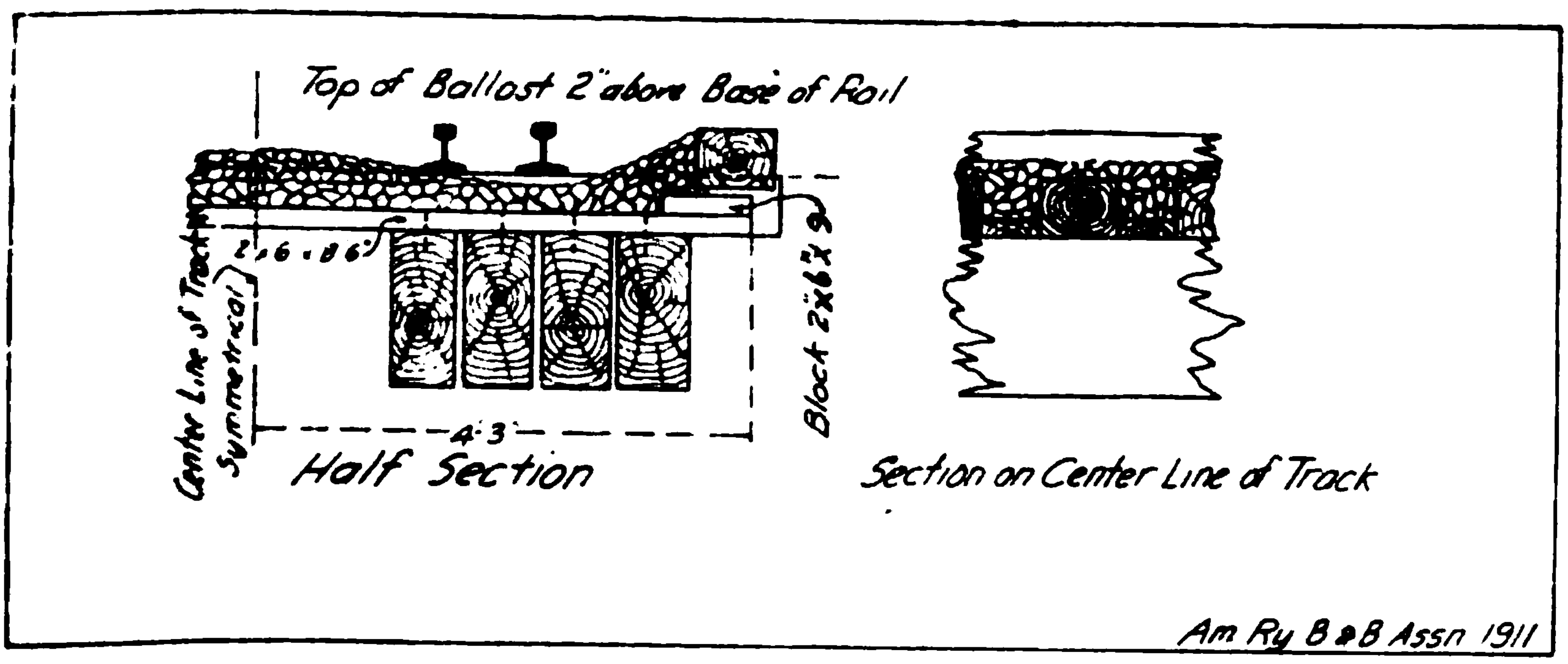


Fireproofing for Timber Trestles.

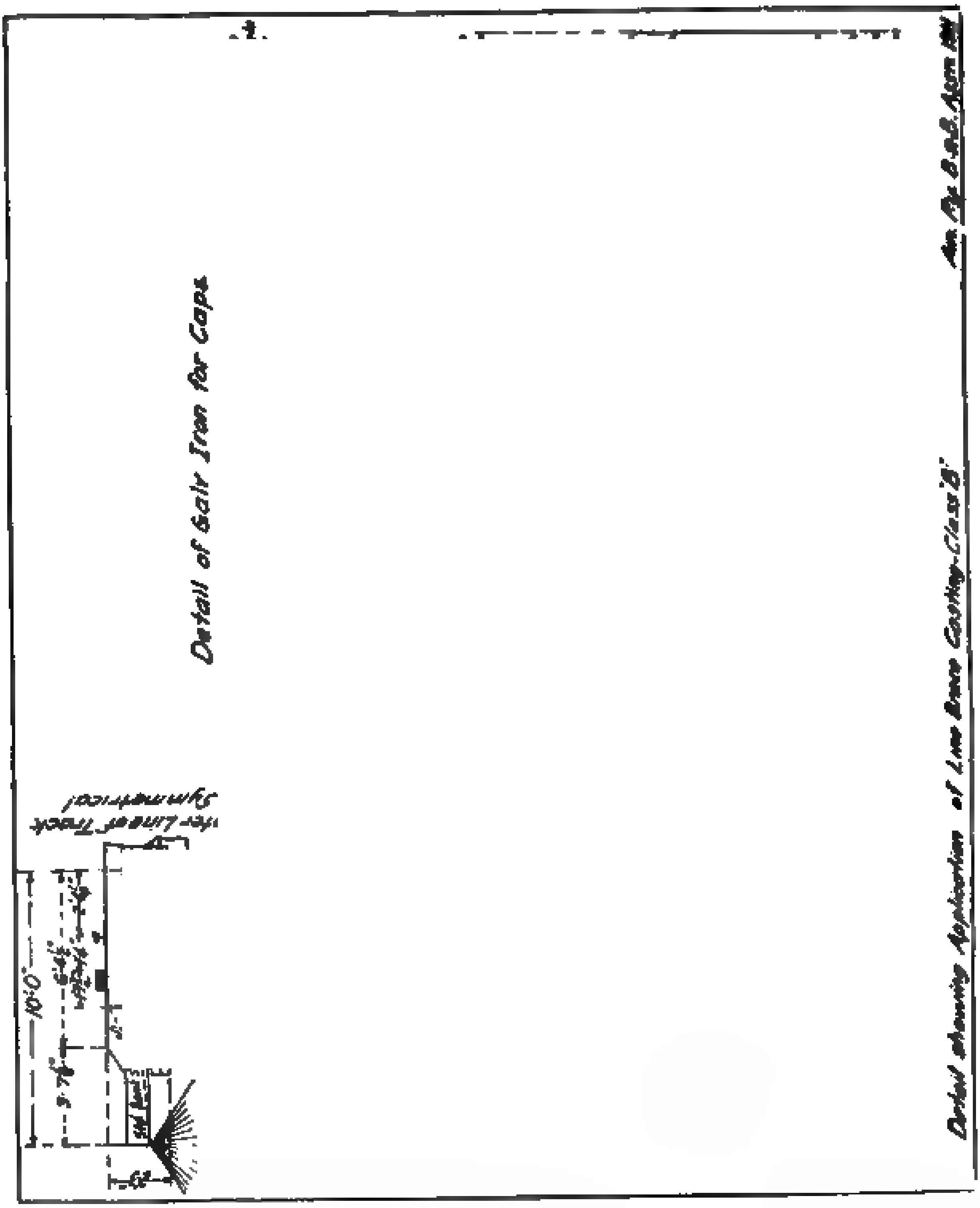
Chicago, Burlington & Quincy R. R.



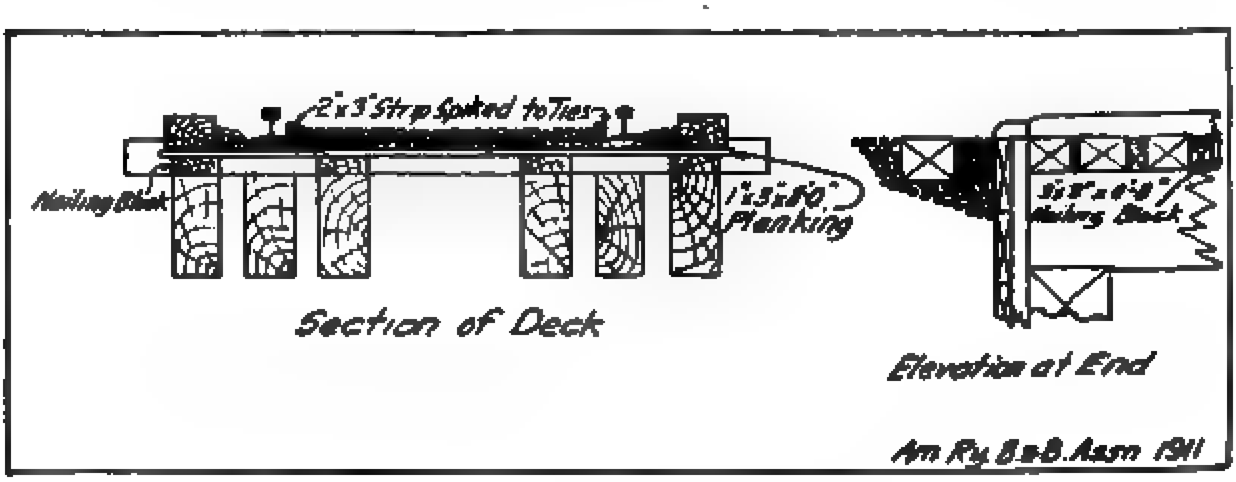
Fireproofing for Timber Trestles.
Minneapolis, St. Paul & Sault Sainte Marie Ry.



Fireproofing for Timber Trestles.
Atchison, Topeka for Santa Fe.

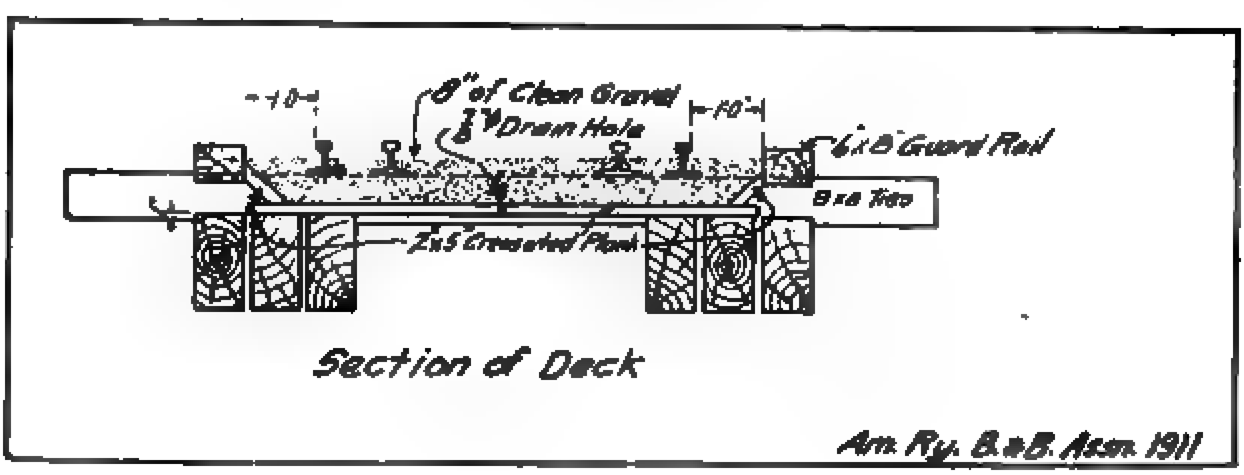


Fireproofing for Timber Trestles. Nashville, Chattanooga & St. Louis Ry.

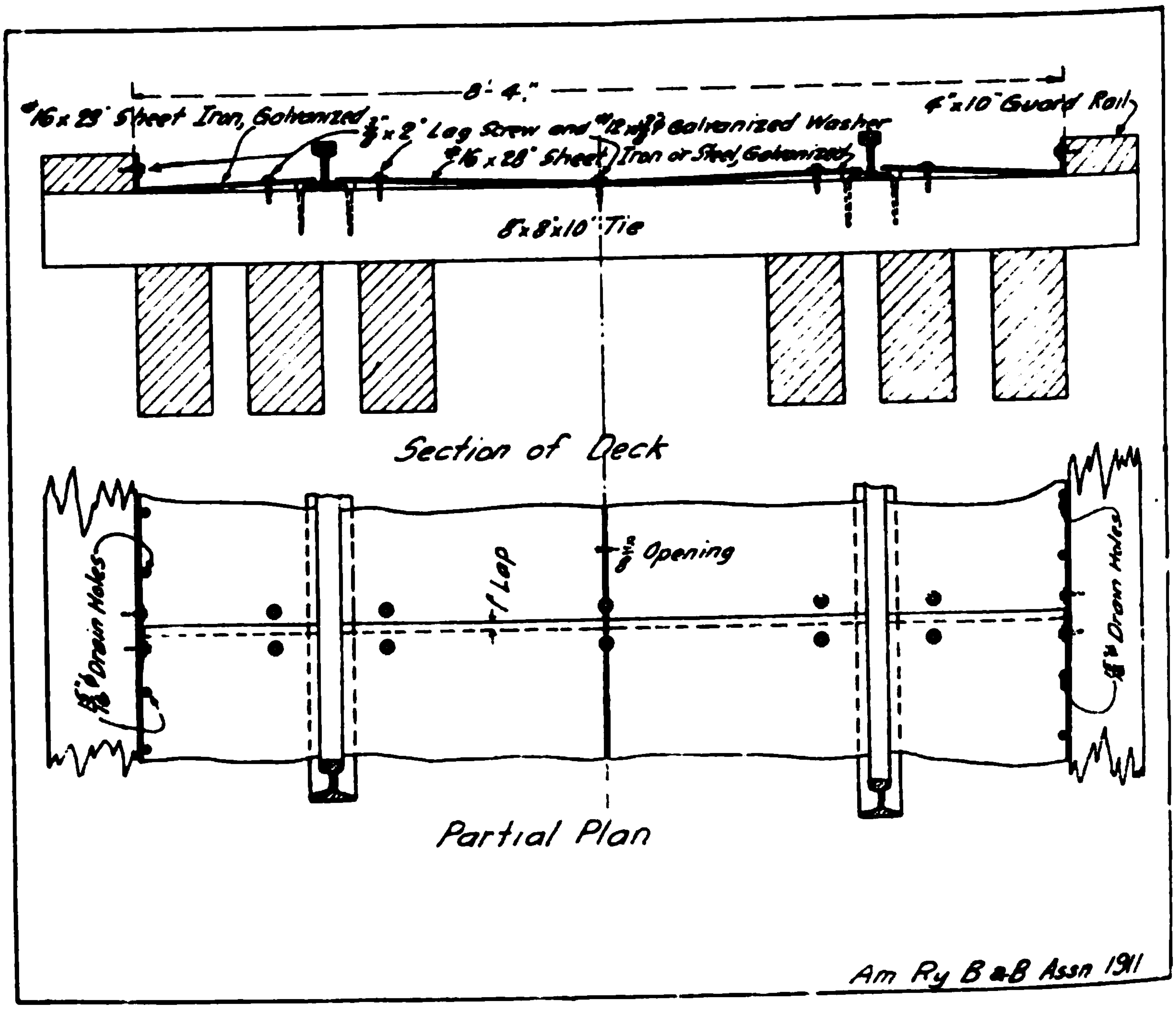


Fireproofing for Timber Trestles.
Oregon Short Line Ry.

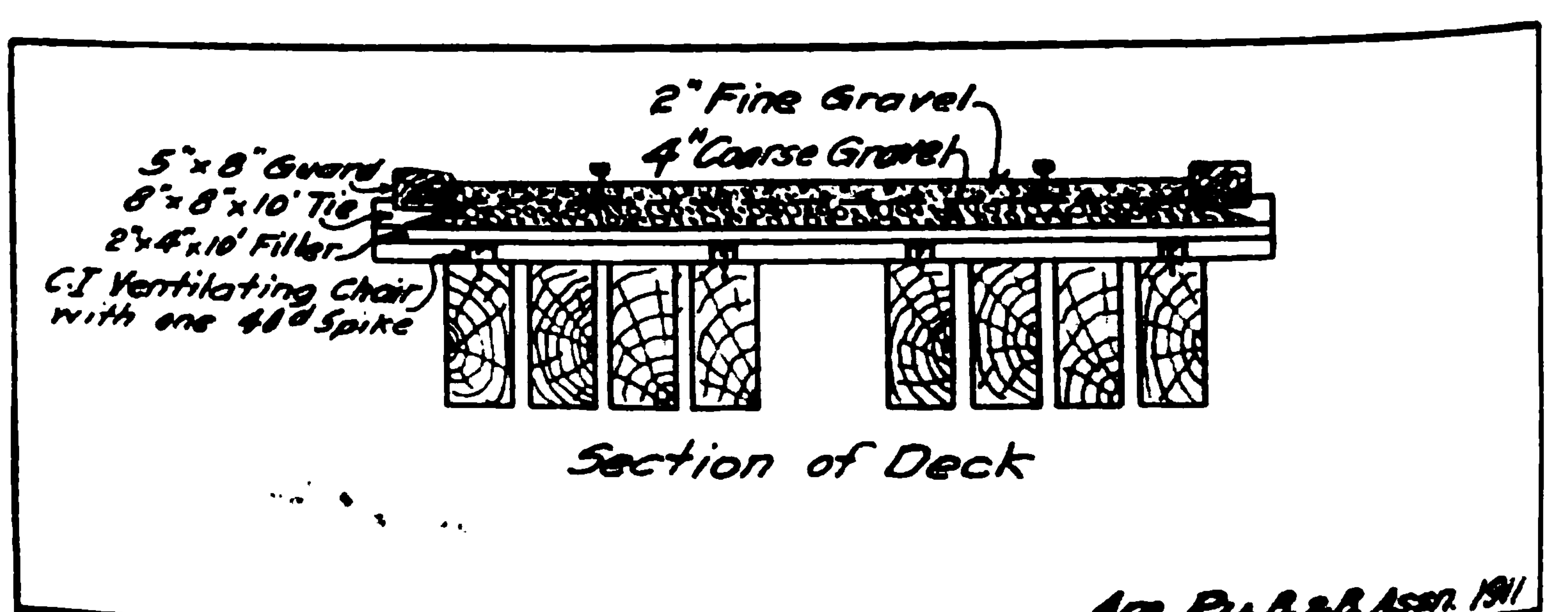
Fireproofing for Timber Trestles.
Chicago, Rock Island & Pacific Ry.



Fireproofing for Timber Trestles.
Norfolk & Western Ry.

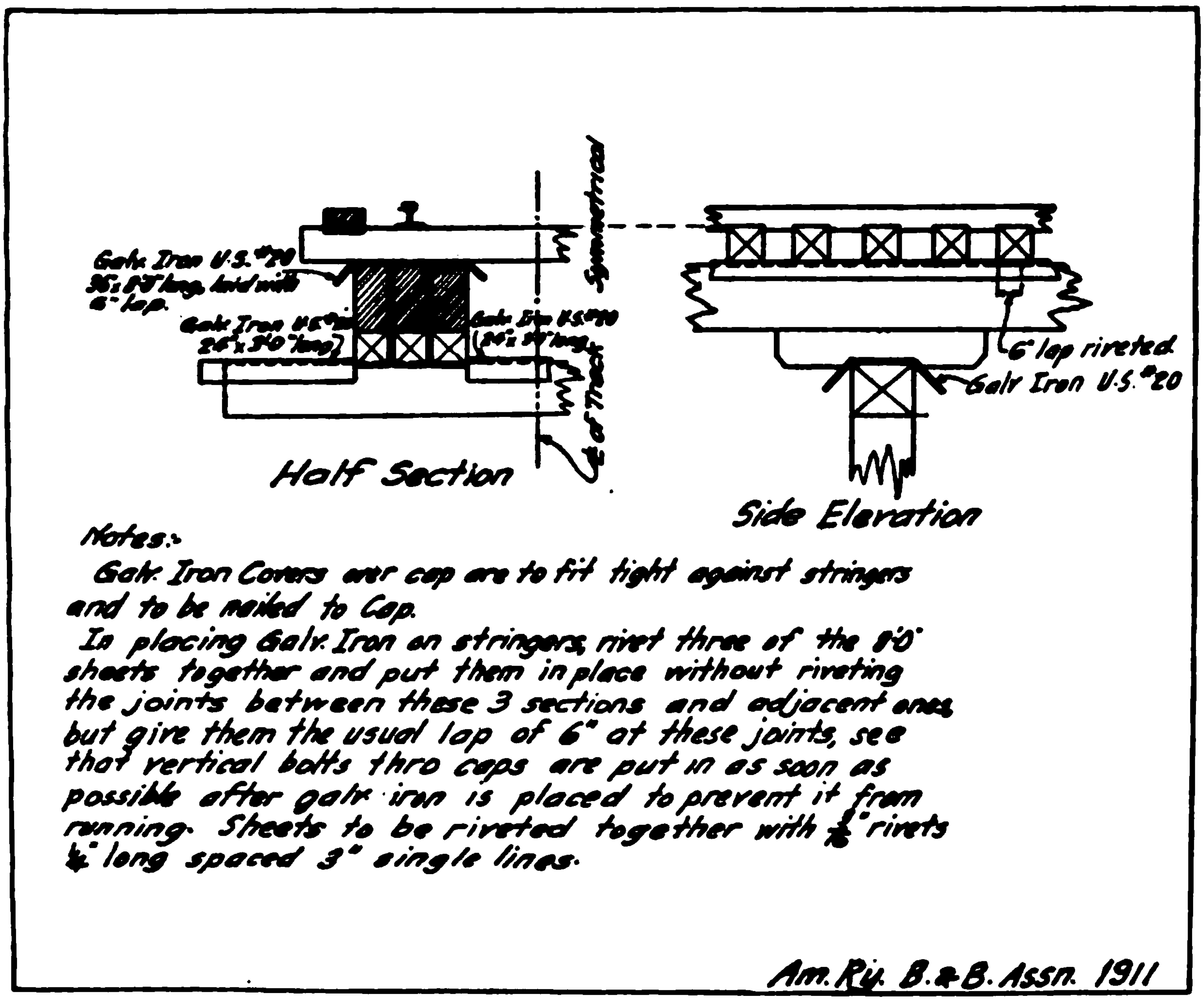


Fireproofing for Timber Trestles.
Chicago & Northwestern Ry.



Fireproofing for Timber Trestles.

Western Pacific Ry.



Fireproofing for Timber Trestles.

Louisville & Nashville R. R.

DISCUSSION.

Mr. Jutton, the chairman of the committee read the report.

The President:—Gentlemen, you have heard the report. It is now open for discussion.

Mr. A. S. Markley:—Two things are destructive to bridges which are not mentioned in the report. One of them is the carelessness with which the mechanical department maintains the fire-boxes of the locomotives. If we can prevent hot coals escaping from the fire boxes we will eliminate one of the causes. When such fires occur, attention to the fact should be referred to those who are responsible for the condition of the fire-boxes. Another cause is the presence of rotten timber in bridges. Some will maintain that they have no rotten timber in their bridges. I will venture to say that 90 per cent of the fires that occur on bridges result from rotten timber, or loose material which collects between the ties or stringers.

Fireproofing increases the cost of a bridge, and I would like to bring out, in this discussion, the point as to whether or not it increases the life of the structure; and, if so, to what extent. If, with a ballasted-floor bridge, we can get 10 to 20 per cent additional life out of the structure, over one which has not been treated in that manner then we might be justified in using such methods. It is claimed that fireproof paint is a timber preservative as well; if that is so I would like to know about how much longer it would extend the life of a bridge. This is an important factor in connection with the subject. On a large road which has a great number of temporary bridges the cost of fireproofing would amount to considerable, and, after all, it is a question in my mind as to whether it pays to do it.

Mr. Killam:—I quite agree with Mr. Markley that the dropping of fire on bridges by locomotives causes fully 90 per cent of the fires, and that rotten timber is a great source of danger. Our iron spans have hard pine decks. We have but a few pile bridges on the Intercolonial Ry., and we have never had a fire on them from rotten wood. On my first inspection I found that no attempt had been made to dress off the sap-rot. I immediately issued instructions that this should be done. I discovered some bridges which had ties that appeared so rotten as to require immediate renewal, but after trimming off the sap-rot they lasted several years longer, as well as being safe from fire. All of our bridges have water barrels sunk in the ground at the ends, and the longer structures have them stationed on the decks at intermediate points besides.

New decks, if saturated with Carbolineum Avenarius, are safe from fire for a period of four to five years. Sap-rot appears after that and care should be exercised to see that it is dressed off. We have never had a disaster on account of a burned bridge.

The President:—I would like to call upon the members who contributed to the report on this subject. We would like to hear from Mr. Hadwen, of the St. Paul road.

Mr. Hadwen:—I would suggest that we hear from Mr. Yappen instead. This subject is more directly in his line of work. There is one phase of the matter which I would like to have explained. The report mentions one road which uses zinc for a metal covering. I would like to inquire why such expensive material is used for that purpose if ordinary galvanized iron will last as long as the structure which it is placed upon for protection?

The President:—We will take up that phase of the subject a little later; may we now hear from Mr. Yappen?

Mr. Yappen:—We have a great many bridges protected with gravel, and we prepare the decks in several ways. In some instances we place the boards longitudinally over the ties and put the gravel upon them. We also make use of a method of putting inch fillers between the ties, placing them so they will come an inch below the top of the tie, and then fill over with about three inches of gravel. The latter method prevents the gravel from shifting along on the bridge. We use galvanized iron and other kinds of iron for covering, any of which I think are better than the gravel covering, especially when we consider the matter of protection from the weather. They are also of greater value as a fire preventative, for, if the gravel works off in the case of the board covering the wood is exposed to the fire which drops from locomotives.

The President:—We would like to hear from Mr. Robinson of the Chicago & North Western Ry.

Mr. Robinson:—The question of fires on bridges originating with locomotives has been up with us considerable and our superintendent of the motive power claims that they occur with a type of fire box that was required by the government; but lately they have been improved, so that the danger from fire is much less than formerly. Nearly all of our fires are caused by hot coals from locomotives.

We have a cheap method of fire protection that we have used to some extent. It consists of one inch by six inch boards which are laid longitudinally on the ties, inside and outside of the rails, and then covering them with clay or loam; but blue clay is better.

We place about three inches at the rail and four inches in the center of the track. It is packed down ordinarily with a shovel, as the men put it on, and the flanges of the wheels make a groove along the rails which carries off the water. It makes the floor practically waterproof as well as fireproof. This method costs about 37½ cents per lineal foot of bridge and is very effective.

Mr. Noon:—We use No. 24 galvanized iron over the main stringers under the ties. Our main chord is 26 inches across in width, and we use a 28 inch sheet which projects over the edge one inch on each side. We have tried gravel and clay, but with very little success. We are using what we call stamp sand, which comes from the copper stamp mines. This affords more protection to the timber than either clay or gravel, and gives good service.

The President:—That is the kind of information we want to bring out—the usefulness of the various kinds of coverings.

Mr. M. Bishop:—We use a ballasted deck, built up with treated timber. Probably ten per cent of the bridges on my division are so built. We first used ballast protection on top of the ties. We have had no trouble with fires dropping from engines in either case. That is about the extent of our fire protection.

The President:—We would like to hear from a representative of the Missouri Pacific, Mr. Smith.

Mr. C. E. Smith:—We have about five miles of trestles built on a new line in 1904 that were protected with gravel decks, and we have done nothing in the way of fire protection since until within the last three or four months. We use No. 33 gage galvanized pure iron on top of the stringers and caps and intend to keep that method going until all trestles have been protected. We are not making any special effort to protect all of them at one time, but are doing it in the ordinary course of renewals. We have about 150 miles of trestle on our line, and the fire losses run pretty high. We hope, in the course of eight or ten years, to extend this protection to all of them.

Mr. Penwell:—There is just one or two things that I want to mention in this connection. I think that the first place to begin to protect a pile or wooden bridge is at the ground, seeing that all of the combustible material is kept cleaned away from the bridge, which can be done by the section men. In the next place, bridge men are liable to be careless in removing decayed timber. They pass it by, thinking nothing of it as long as a bridge has the necessary strength. I regard it as a very important matter that the rot-

ten wood be cut away from all wooden bridges. When any portion of a piece of timber gets rotten it becomes a firetrap.

I agree with Mr. Markley that one of the most important things is to secure better attention from the mechanical department in regard to locomotive fire-boxes. We had two cases where the ash pans were actually dumped on wooden bridges, setting them on fire. I think we have a right, and I think it is perfectly consistent, to recommend to the general managers of the railroad companies that more care should be exercised in the handling of engines, to avoid the dropping of live coals on bridges. This can not be eliminated entirely, but it can be reduced to a reasonable minimum.

One more point I want to touch upon is this; if we pile clay or gravel or anything of that nature on bridges, we shorten their life. When the condition of a bridge is such that its renewal becomes necessary within six months or a year, and there is a considerable amount of rotten timbers that can not be cut away, our practice is to place a covering of mud on the ties as a temporary protection.

Another means of protection which has been mentioned is that of painting, which has the additional advantage of lengthening the life of the bridge. This method also should receive due consideration. If we get a paint or whitewash (or whatever the mixture may be) that will protect bridges from fire, I believe that it should be used. Some of the eastern roads use whitewash to good advantage. This is a very cheap method and affords good protection, but it does not look well, which is about the only objection to its use. I would, therefore, strongly recommend use of fireproof paint.

Mr. J. H. Markley:—I do not wish the committee to infer that I want to criticise their report, because it is a good one and contains much information, yet at the same time there is something lacking. One thing that appears desirable to me in conjunction with fire protection is to preserve the timber, which is of as much importance as to protect the bridge from fire. There is nothing in the report to indicate how the iron is to be held in place on the bridge to prevent it from creeping. How is it applied, under or over the ties? Does it extend under the rail?

Mr. Jutton:—I will explain that in the printed copies of this report, which we will have at hand shortly, there are thirteen drawings representative of the several types of fireproofing, showing details of construction of each type.

In regard to asking the motive power department to instruct their men to avoid dumping hot coals on bridges from the engine fire-boxes: I quite agree that this is something that should be done

and if a few men who violate such a rule were disciplined such action would have the effect of causing others to be more careful and in this way a great many fires might be avoided. The committee thought, however, that a matter of this kind should not be included in the report, except to say that coals dropped from locomotives cause the majority of fires on bridges.

It should be noticed that this report deals with fireproof construction for timber bridges, and not with the cause of fires on bridges, such as the dropping of coals by locomotives, etc.

Mr. Penwell:—I do not want the committee to understand that I am criticising the report in any manner, but I do insist that we have a right to recommend a fire preventative. As Mr. Jutton suggests, the worst enemy we have to fight is that of the reckless distribution of hot coals along the track. We can point out the causes of the fires and then recommend, so far as we are able what is necessary to protect the bridges. Therefore I think we should not hestitate to bring the matter pertaining to defective fire-boxes and ash pans to the attention of the managements.

Mr. Jutton:—Certainly; but the committee report is intended to deal with fireproofing of trestles and not with the prevention of scattering of fire. If the causes of fires on bridges could be eliminated there would be no occasion for fireproofing trestles, and in that case this subject would not be before this meeting.

Mr. A. S. Markley:—There are other members here who have their bridges fireproofed. In the absence of the printed reports, let them get up and express themselves. There is John Markley; he has had a lot of experience along that line and does not say a word.

Mr. J. H. Markley:—There are many here who are better talkers than I. I have had a great deal of experience in the way of fireproofing of bridges and protecting them from the weather as well. The first work I did of this nature was seventeen years ago. We covered only the stringers at that time, using No. 26 galvanized iron. Last spring, on account of the timbers being light for the traffic we had to put in an additional stringer. When we removed the covering from these stringers which had been on for seventeen years we found the timbers as sound as they were the day they were put in. We simply added another heavy member and then covered them again. Instead of covering the stringers only, we now cover the entire deck of the bridge with No. 22 galvanized iron.

The method of fastening the covering was as follows: At every joint we used a two inch lag screw and washer, both of which were galvanized. A slot hole was made about an inch long and half

an inch wide, allowing plenty of room for the expansion of the metal. The lag screws were not drawn down tight. On some bridges the galvanized iron is placed beneath the rails and the spikes are driven through it. I do not like that method so well.

About a year ago we built a new trestle, about 325 feet long, and on that the iron was brought up under the ball of the rail which makes it practically fireproof as well as weatherproof. It was the first bridge we covered in that way, and it seems to be very satisfactory. This work costs us about a dollar per lineal foot of bridge.

When we used the stringer covering it would last just about as long as the ties; every time we renewed the ties we renewed the metal, which was about every eight years.

Mr. J. B. Teaford:—Mr. President, I was going to be quiet for awhile and hear the older members give their experience. We use the same methods for fire protection of wooden trestles that have been mentioned here, namely, the ballasted deck, ballasted floor, and galvanized iron. We use No. 20 galvanized iron sheets over the three-ply stringers, 30 in. wide and 96 in. long; for the caps we use sheets 22 in. wide and 87 in. long. We secure those plates by bolting through the tie and the stringer, which serves as an anchor bolt against the shifting of the ties on the stringers and also to prevent the deck from floating in high water; and, as the gentleman has just remarked, it is a good protection against rain and snow, and it preserves the timbers. We have quite a number of ballasted deck bridges but for fire protection at a low cost I prefer the metal covering.

Mr. Shedd:—I want to refer to a point which was brought up this morning. Many roads have submitted plans for fire protection of bridges in connection with this report, and I would like to know why each road adopted its particular type of construction. Was it because of disastrous fires or something else? I think that the fact that a good type of fire protection also protects from the weather has had a great deal to do with the adoption of fireproof construction on the several roads. If the life of the bridge is prolonged, say 30 or 40 per cent, then the fire protection costs practically nothing, which I think is a good argument for its adoption.

I have in mind a line of road 160 miles in length, which has 16 miles of bridges about six years old. I am quite sure there has never been a fire on any bridge on this line, and I think, owing to the great cost, it would be a hard matter to get the chief engineer to approve of any type of fire protection on these bridges, for fire protection alone. But if it could be shown that the life of the

bridges would be prolonged sufficiently to pay for this fire proofing he would very likely approve of the construction.

Mr. Markley:—Just one word; I do not care to do all of the talking in connection with this subject. Only the ties, stringers and caps can be protected. We cannot protect the piling. They are left unprotected, by any of the methods that have been mentioned.

Mr. Smith:—This question was gone into at great length by the American Railway Engineering Association last March. Up to that time I had kept a record for about eighteen months of our fires, and found that about 95 per cent of them began on top, practically due to negligence, and about 5 per cent came from below. We found that it did not quite pay. From a financial standpoint it would not pay 5 per cent on the investment to fire-protect all of those bridges either with gravel or with galvanized iron, taking into account only the cost of rebuilding the trestles. We did not include what it would cost to detour trains, the overtime charges, the expense of train crews and other figures along those lines. We had no insurance figures for the possible wrecks which might cause great loss of life. At that time Mr. Courtenay, chief engineer of the Louisville & Nashville road, stated that his company had been using galvanized iron for covering caps and stringers for about twenty years; that he had taken off the iron to replace it and found stringers that were twelve and fifteen years old which were practically as good as they were when they were put in the bridges. We have on our lines a great many combination spans, the top chords of which have been covered with sheet iron for many years, and it has been a great success. From that we assumed that we were making a saving of 50 per cent at least, when we protected them with sheet iron, and on that basis it would show a profit of 20 to 30 per cent on the investment.

Mr. Aldrich:—Earlier in the discussion Mr. Hadwen inquired as to the reason for using zinc for metal covering instead of galvanized iron. I will give the reason for that. It may not be generally known that galvanized iron or steel will last only about two years in the vicinity of salt water. It would not be policy to use zinc where galvanized iron would answer the purpose, as it will in most cases.

We use metal covering only where fires are liable to occur frequently, and it gives good satisfaction. We place it above the ties on tapered blocks which slope downward from the rail toward the center of the tie. We do not permit the covering to touch the rail, for if it did it would interfere with the operation of the signals.

I think the whitewash suggestion came from the New Haven road. I have used whitewash on trestles with good success, both as a fire preventative and as a timber preservative. I think that it will increase the life of timber at least 20 per cent.

Mr. Pickering:—I have not heard any one speak about the painting of bridges for fire protection; hence I will give my experience. We have a double-track pile bridge 275 ft. in length which was painted about a year ago with a fire-resisting paint. This bridge carries on each track about 60 passenger trains per day, besides extras and freights. It took fire in September, as a result, undoubtedly of a live coal that dropped from the fire-box of a locomotive into a place between the tie and the stringer which was unprotected. The timber burned so slowly that we were able to extinguish the fire before it did any great amount of damage. I think we had a very good demonstration of the effectiveness of fire-resisting paint on that structure.

We also use whitewash and a cement wash for the same purpose. With these materials we fill cracks in the ties as well. They have proven to be very efficient. I would recommend the covering of caps and stringers with sheet iron and the painting of ties and guard rails with fire-resisting paint.

Mr. W. O. Eggleston:—If metal covering is used on stringers and caps how is the inspector to see the condition of such timbers? That brings up an important question. When timber becomes a few years old and we are a little suspicious of it, how are we to ascertain its conditon when covered in that manner?

Mr. Pickering:—I would suggest that the metal covering be made wide enough to extend over the timbers about three inches, and that it be not turned down at right angles, but simply bent at an angle of about 45 degrees. I think it would be no very difficult matter to inspect near the top of the timbers in that case.

Mr. Eggleston:—That is true for outside stringers, but where there are three or four in each chord how is the inspector going to see the condition of the inside ones?

Mr. Pickering:—I think that the metal protection over the stringers will not only act as a fire protection, but will also protect the timber from decay, so it is safe to assume that the stringers will be in good condition during the life of one set of ties. When the ties are changed the metal can be removed for repairs or renewals and then there will be abundant opportunity to inspect the condition of the stringers. Again, if the stringers become decayed on top, the constant pounding of heavy traffic, I think, will develop

kinks in the iron as the tie settles into the stringer, which would suggest a detailed inspection.

Mr. Shedd:—Some years ago the Chicago & North Western road constructed pile bridges with a sheet iron covering over the stringers and also over the caps where the stringers rested. Such construction makes inspection somewhat difficult, but our experience has been that the stringers and caps on these bridges lasted considerably longer than when not covered, and when the timber becomes poor it can be easily detected on the underside. A good way to inspect timber covered in this way is to bore into it. There is no doubt in my mind that this manner of construction adds about 25 per cent to the life of the timber.

Mr. Eggleston:—Decayed places in stringers can be detected by boring, but where metal covering is used this method is not practicable. The same is true where stringers become broken or split. For that reason I do not believe in covering stringers.

A Member:—I know of several railroad bridges that were in use for thirty years which had the stringers covered with two-ply tar paper, projecting about an inch. When these stringers were uncovered they were found to be practically as good as the day they were put in. This covering lessens the liability of fire, as well as prevents decay.

We are creosoting the under layer of planking for overhead highway bridges. We do not creosote the top layer, for it is not subjected to the hot blasts from locomotives; and, besides, it is being constantly changed out on account of wear, and not because of decay.

Mr. J. S. Robinson:—About 12 years ago, while engaged on bridge inspection, I found that a live coal got underneath the sheet iron metal covering of a pile bridge and burned the stringer nearly in two before we got the fire extinguished. The red hot coal dropped through the covering where there was a corroded spot, where the weather caused the sap wood on the top surface of the stringer to decay, and it took fire quite readily.

Last year we had a Howe truss span 120 ft. long which took fire at the bottom of a batter post. The chords of this truss had a metal covering, but the wind carried the fire right along under this protection and the entire span was destroyed.

During the last three years, on one of our lines we lost about $16,000 worth of bridges by fire. They were not protected in any manner. While our company was getting up a standard design for a covering we tried the mud and clay covering which I mentioned

before. Some of this covering has been in use for three years. This year we removed the mud from one of these bridges and found that the ties were almost as good as when we adzed off the sap-rot, and we decided that they were good for two years more, at least. I consider that method of covering cheap and efficient. It protects the timber from decay as well as from fire.

Mr. Eggleston:—A few years ago we had a fire on a 200-ft. deck truss. The ties were 8 in. by 16 in. and had been creosoted. They were set on fire from some unknown source, probably from a locomotive. The timbers were charred at least half an inch deep the entire length of the bridge, and they would have been destroyed if the fire department had not put out the fire. As it was, the heat was so intense that it ruined the rails on the bridge. Now that does not appear as if the creosoting of timber made it fire-proof.

Mr. Jutton:—In regard to the burning of crosoted timber: I wish to say that in the appendix to this report there is a letter from the engineer of tests of the New Haven road in which he gives the results of tests made on the burning of creosoted timber. He states that the presence of the creosote makes a very hot and fierce fire, and in this way hastens the destruction of the timber; hence we conclude that creosote is not beneficial as a fireproofing material.

Mr. Andrews:—I have listened with a great deal of interest both to the reading of the report and to the discussion, all of which seemed to me to be exceptionally valuable. There is one thing, however, that seems to have been overlooked which I believe is one of the best fire protection measures that we could suggest, and that is, fill the trestles. That may sound queer. I travel over a number of railroads during the year in various parts of this country, and it is astounding to me, and it is to many others, to find so many long trestles, for the existence of which there is absolutely no excuse except the first cost of a permanent structure. There are hundreds of them that could be filled and require nothing larger than a 24 in. pipe for a waterway.

Mr. A. S. Markley:—A point of order, please. We are talking about the fire-proofing of trestles.

Mr. Andrews:—I am talking about fire protection; if I get away from it call me down.

The President:—I think your information is valuable.

Mr. Andrews:—We fill a great many trestles, more for that purpose than for any other and you would be surprised if I told the number of high and long trestles we have filled in the last three years, over iron pipe as small as twenty-four inches in diameter.

There are hundreds of places where a trestle is necessary, of course, from the point of economy, but there are just as many more where there is absolutely no necessity for maintaining them. I have lately inspected a large portion of our road, and my recommendations this year will point to a number of long trestles which should be filled, and they will be filled.

In many cases trestles could be filled with material that we simply waste on the slopes. There are many trestles that could be filled leaving a 20-ft. opening; there are many that could be filled leaving a 30-ft. opening and many that could be filled leaving an opening as large as 60 ft. The first cost is heavy, but ultimately it pays. In the past few years we have filled a number of trestles where we built 60-ft. arches.

I appreciate the fact that many roads pass through country where the filling of trestles would be difficult or very expensive, but a large number also pass through a country where material available for filling is near at hand. I can only point to the city of Chicago, where railroad companies are now using sand from the hills along the lake for elevating the roads. Such material could also be used for filling trestles.

Concerning the policy of placing sheet iron on the top course of timber, I fully agree with Mr. Eggleston; I think it is a dangerous practice. It will eliminate fire danger to a certain extent, but vibration of the structure and other causes will ultimately make holes in the iron into which a hot coal may lodge and smoulder for a long time and finally a fire will break out and destroy the bridge, or a part of it.

In conclusion I will say that fire protection is a good thing, but I believe in filling trestles where it is practicable. A watchman should be employed where large trestles are maintained.

Mr. A. S. Markley:—I do not agree with Mr. Andrews.

Mr. Andrews:—I did not expect that he would.

Mr. A. S. Markley:—Where bridges are protected with metal covering the timbers will last at least fifteen or twenty years. It is the only kind of protection I would recommend for a bridge.

Mr. Schall:—We do not protect stringers on wooden trestles against fire. We have no wooden trestles on our main line, but we have them on the branches. I have nothing to say on fire protection, but I would like to know how iron covering is maintained by railroads that transport a large number of refrigerator cars. On our main line it would last about one year and then conditions would be worse than if the timbers had been unprotected. For that rea-

son we do not use any covering. We do, however, insist on cutting off all the sap-rot and keeping rubbish away from structures that might catch fire.

The President:—The point brought out by Mr. Schall is a very good one.

Mr. J. H. Markley:—When we cover the stringers of a bridge we do not apply it until the bridge is a year old. By that time the tannic acid is out of the timber or is supposed to be; then the iron does not rust so readily. I have heard some argument about the iron breaking at the edges of the ties. I have never had any such experience. Sometimes the iron will rust under the ties. When it rusts out we renew it. The cost is about 15 cents per linear foot for renewal.

Mr. Aldrich:—My experience has been that fires start between the rails resulting from coals dropped from the ash pan. I do not know of a case where we have had a fire that started outside of the rails. Salt brine drippings from refrigerator cars do no damage to metal covering between the ties. It is from ten to fifteen inches outside of the rails where the salt brine drips.

The President:—I would like to take Mr. Aldrich over the Chicago & North Western main line between Chicago and Omaha and show him the effects of salt brine between the rails; it corrodes the spikes and rails to a considerable degree on the east bound track; but it causes no trouble on the west bound track. The report, as you know, has no specific recommendations made by the committee and it is virtually a summing up of the different practices on a number of railroads. What we want to bring out is the sense of this meeting in regard to fire protection, and then make a recommendation of some kind—bring out the pros and cons, and get as much information as possible for the guidance of those who have to deal with such matters.

Mr. Smith (Mo. Pac. Ry.):—It might be a good thing to defer final action until tomorrow afternoon. We have one trestle on our system that has been painted recently with fire-resisting paint, and I understand that it has been arranged to take the delegates there to witness a fire test. Only one speaker has been able to tell us anything about fire-proofing by painting. Tomorrow afternoon all of us who go out to that bridge will perhaps know more about it than we now do.

The President:—I believe that the suggestion is a good one. We will also likely have the printed reports by that time. I think

that for those reasons it would be well to defer action on the subject until tomorrow.

TEST OF FIRE-RESISTING PAINT.

The members of the association were taken, Wednesday in a body, to witness a fire test on a Missouri Pacific Ry. bridge which had been treated with a coat of Clapp's fire-resisting paint. The test was conducted about as follows: A pile bridge, about 130 ft. long, had been treated with one coat of the fire-resisting paint by the Missouri Pacific forces, under the supervision of Mr. C. E. Smith, engineer of bridges. A locomotive was passed slowly over the bridge several times, dumping live coals as freely as possible, with the result that the fire died out without damaging the structure. This bridge was 10 or 12 years old.

A dummy span of timbers several years old had been erected on the right of way, at one side, which had been treated likewise with paint of the same kind. About this structure was scattered a bale of straw and other combustible material, which, when ignited, made a flame 10 to 15 feet in height, which blazed up through the timbers fiercely for several minutes. When the fuel had burned up the flames died out, save at two places where the stringers were partly covered with a resinous pitch. Here they burned fiercely in the breeze for over a quarter of an hour, but the flames finally died out of their own accord. There was no doubt in the minds of those present but that the paint proved itself to be a fire retardant, and the test was considered a success.

DISCUSSION CONTINUED.

Upon returning to the convention hall the discussion of the subject was resumed.

The President:—The discussion on this subject was deferred, yesterday, until after the test of the fire-resisting paint, which we have just witnessed. We will now continue the discussion.

Mr. Jutton:—Mr. Moore, one of the members of the committee, suggested to me that we get an opinion from the association as to which type of fireproofing it favors; then, with that as a basis, investigation could be continued by the committee, recommending the details of construction for such a type and report next year. I would like, therefore, to have the association indicate which type of fireproofing it favors.

The President:—The discussion had about stopped at the point where there was a divided opinion, as to whether or not it was advisable to use any fire protection at all, considering the expense. I believe it would be a good idea to find out whether or not we should make any definite recommendation as to the advisability of using fire protection.

Mr. Fake, were you here during the discussion of yesterday? If so, what are your views in regard to it?

Mr. Fake:—I was present yesterday. I have had but little experience in fire protection work. The little we are doing is at a special place where we have an approach to protect a span 45 or 50 ft. high. We built some low concrete piers about a foot above the surface of the ground, placed the bents upon them and put a ballasted floor on the trestle. We would not have gone to the expense of a ballasted floor except as a means of fire protection. It occurred to me, after today's demonstration, that the committee during another year could make examinations and tests of fire-protective paints. If they would take several temporary trestles, similar to the one we saw today, and treat them with the various fire-proof paints, and then take another one and treat it with some ordinary oil paint, say oxide of iron or something of that kind, then take one that is not treated at all and put them to test, the results would give useful information to us. I am of the opinion that it would be wise for us to undertake such action.

Mr. Stannard:—I have heard a number of men remark, since the demonstration this afternoon, that the expense would perhaps bar many railway companies from painting their bridges with such paints, even if they proved to be a success.

Mr. Penwell:—I like Mr. Fake's suggestion, and along with such tests that he has mentioned I would like to have common whitewash tried under the same conditions and compared with the more expensive paints. Whitewash sounds a little cheap, but it is just about as good as any wood preservative, and it is a protection against fire, at least to some extent. I know of some bridges in the East that have been whitewashed and have been very successfully protected against fire. I am not partial to whitewash, but, if we cannot afford to paint bridges with the more expensive fireproof paints, perhaps we can afford to cover them with whitewash.

Mr. Jutton:—I want to make a correction in regard to the figures given in this report as to the cost of applying fireproof paint. We have just seen a demonstration of the Clapp fire-resisting paint applied to one of the bridges on the Missouri Pacific Ry. The cost

of painting this single-track pile bridge was about 29 cents per lineal foot. The cost given in the report is 16 cents, which is too low. It is also stated in the report that the price per square foot is 1¼ cents, which is perhaps a little too high. One cent per square foot would be about right.

The term " fire-resisting paint" is meant to include any and all liquid coatings which have fire-resisting properties, even such as whitewash.

Mr. Fake:—I have never thought it was of very much value to apply such paints with a brush. I have always been of the opinion that if anything of that kind is applied, the timber should be dipped, or if it is painted the paint should be applied after framing and before erection. Nearly all fires in trestles, at least a large proportion of them, originate in joints which the sheet iron cover is intended to protect. It is very difficult to apply paints to the joints at the ends of the stringers and between the stringers. It is a very uncommon experience that we have a bridge catch fire from the ties. Coals will roll over into the joints, and such are the places that should be protected.

Mr. Jutton:—I would suggest that Mr. Penwell read Mr. Sheldon's letter. You will find it in the committee report.

Mr. Penwell:—I find that this letter covers what I had in mind with reference to whitewashing.

The President:—Personally, I take very kindly to the suggestion made by Mr. Fake that we, as an association, conduct some tests with the various fire-resisting paints, in order that we may have something of value for the report at the next meeting. I have no doubt but that one or more railroads will be sufficiently interested to permit of some tests being made on their road. We are somewhat in the dark now. We certainly could not, as an association, recommend consistently any one type of protection reported upon by this committee.

Mr. J. O. Thorn:—In the Spring of 1889, I built a pile trestle, 800 ft. long, across an island in Rock river about ten miles from Rock Island. At each end of this trestle there were a couple of through spans, and there was considerable switching done there. We kept bridge watchmen there, for it was a dangerous location. Partly as an experiment, partly as a preventative of fire, and partly on account of the belief that it would be a wood preservative, I applied common salt by putting a board between the ties over each bent of piles, and had the bridge watchman keep salt there all the time. I do not know how many fires were started on the ties by

engines switching there during the life of this trestle, but there were a number. However, the fire never crossed that salt, and the bridge watchmen were always able to put out a fire with a bucket or two of water. The last of those ties were removed in 1910, and they were not rotten. The grade of the bridge was changed and finally all of the piles were taken out, and they came out in a very fair state of preservation at the end of 21 years.

We have another pile trestle about a thousand feet long which is a little over eleven years old that was similarly treated. I made an examination of it a short time ago and it is a pretty good bridge yet, there being no reason why it should be taken out on account of decayed wood. I notice that in the German experiments salt is rated second as a preservative. As a fire resistant it is equal to anything I know of. We are using some galvanized iron. Personally, I am not in favor of it.

The President:—I think we have had quite a few expressions as to the advisability of using sheet iron, particularly on top of stringers and caps, some pro and some con, but I think the majority of the members present during this discussion did not seem to favor sheet iron covering of any kind except when used as a covering for the entire bridge, and that of course is a difficult matter in any automatic signal territory.

Mr. Jutton:—The Great Northern road has taken care of the question brought up by Mr. Rettinghouse in regard to placing of sheet iron on top of ties, so that it will not operate the signals in automatic signal territory. They accomplish this by using a four by four inch piece ripped diagonally. This produces a triangular block which is nailed to the ties in the center of the track for the entire length of the bridge, and the edges of the sheet iron are fastened to this block. In this way it is impossible to make a circuit as there is a slight opening in the metal near the apex of this ridge. It is true that this leaves a little unprotected space, but such a thing is necessary where there are automatic signals and trouble can scarcely result from it.

There has been some discussion about how the galvanized iron is fastened under and around the track rail. Where tie plates are used the metal should be cut so as to fit closely around the tie plates and between the ties it should extend under the track rail about a half inch and bent up slightly. Where tie plates are not used a narrow strip of metal is placed lengthwise under the rail and the other strips are connected to this narrow strip with a lap joint.

Another way, where tie plates are not used, is to bring the metal up over the track spikes to the web of the rail.

The chief engineer of the Nashville, Chattanooga & St. Louis R. R. has studied the question of the protection of timber a great deal and has worked up some very good details for placing galvanized iron on caps and stringers, and these are shown in one of the illustrations accompanying the report.

Mr. Penwell:—I move that the subject be continued another year and that the committee be instructed to make such tests as they deem wise.

Mr. O'Neill:—It does seem to me that it would be necessary for the committee to have some financial backing to make the tests properly, and I think that ought to be incorporated in the motion; that the committee should be authorized to draw on the secretary for any funds that are necessary to carry on the tests. With that added, I would be inclined to support the motion.

The President:—Will you accept that amendment, Mr. Penwell?

Mr. Penwell:—I will accept that amendment, leaving the details to the judgment of the executive committee.

Mr. O'Neill:—I support the motion.

The motion was carried.

SUBJECT No. 3.

BEST METHOD OF NUMBERING BRIDGES.

REPORT OF COMMITTEE.

To gather data for making this report the following circular letter was sent out to many officials in charge of bridges on the various railroads:

"Will you please give the benefit of your judgment as to the best method to be followed in numbering railroad bridges, and also what is the practice on your road in this regard?

"If you have any drawings showing your method of numbering, will you please send us a blue print of same?

"We would greatly appreciate hearing from you at your early convenience."

Replies to this inquiry were received from practically everybody to whom it was sent and in the appendix is given a copy of the salient features in each of them.

After going over these replies and attempting to digest them the following facts seem to stand out:

First:—At the present time the number of roads using the mileage system is somewhat, but not greatly, in excess of the number of roads using the consecutive numbering system.

Second:—Where changes are made they are from the consecutive numbering system to the mileage numbering system.

Third:—The consensus of opinion seems to be that on a new line where a scientific system can be put in at the start the mileage system is preferable.

Fourth:—The mileage system seems to present some difficulties if applied to a large railroad with many main lines and branches. (Mr. Bland's able discussion on this subject is especially commended and the attention of members is directed to it as giving a very clear and able exposition of the subject.)

Fifth:—Where the consecutive numbering system is established on an old line of considerable mileage and many branches it seems advisable to retain it. The cost of the change is almost prohibitive. All of the officials on the road know the important bridges by their numbers, so that changes would introduce endless confusion and for a considerable time bridges would be known by either one of two widely varying numbers.

Sixth:—It has been urged against the consecutive system of numbering bridges that it gives no indication as to the location of the structures. This is readily overcome by having a proper record of bridges in the office of record, showing the stations and the mileage and indicating the numbers of the bridges in their proper relative position to these stations and mile number-posts. Mr. Killam, of the Intercolonial Railway, brings out this point very clearly. It is the system in use on the Chicago & Northwestern Railway and on practically all other roads of any considerable mileage.

When a report comes in from the field with regard to a bridge, stating the number, the report is immediately sent to the bridge department, where the bridge record books are kept, and advice can be instantly given as to where the bridge is located, with reference to the stations, on that particular line. This does not locate the bridge closer than between two mile posts and between two stations, but this is as close as can be asked from any system.

SUMMARY.

We do not believe it advisable to recommend any particular system of bridge numbering at this time. The matter has been discussed a good deal, and there are today advocates of the consecutive system as well as of the mileage system, although the former are in the minority.

The attached answers to the inquiry are recommended for the close attention of the members of the association and there is no doubt that conditions comparable to those on any railroad will be found described in one or another of the answers.

We do not believe the association, as an association, wants to recommend any particular system, nor to go on record as advocating that particular system and that system only. The compilation of the answers received makes a valuable addition to the literature on bridge numbering, and we as an association ought to be content with that.

The committee desires to thank the various gentlemen who have so kindly responded to the inquiries for information on the subject of bridge numbering and the methods in use on their various lines.

APPENDIX.

EXTRACTS FROM LETTERS RECEIVED.

J. C. Bland, Engineer of Bridges, Pennsylvania Lines:—In my opinion, the best method of numbering bridges is that wherein every bridge has a number representing a mile post plus the distance from that mile post to the center of the bridge, expressed in terms of stations; for example, a bridge is west of mile post 15 and 1,230 ft. therefrom, the number of the bridge would be 15+12, using the nearest units of 100 ft. In other words, the number of a bridge would be a mile post plus stations. This was what our people adopted many years ago, but we were then in a period of transition in bridge work (and are still). Our present method of numbering is consecutive. In a comparatively short time we will have to face this question in the case of two of our divisions, and it will probably bring up the notation which was decided upon many years ago.

It must be admitted, however, that the consecutive method of numbering has points in its favor, and quite possibly we may, when the time comes, disregard theoretic considerations and retain our present system of numbering. When the question of renumbering our bridges came up for consideration some years ago we planned to make Pittsburg the initial point from which all mileage was to be computed and our bridge signs would merely show the number of the bridge without any initial letter indicating the division, but our bridge records would have a letter which would indicate that.

In the discussion of the subject a great many difficulties presented themselves, inasmuch as some of our lines ran north and south, although the general trend of most of our lines is east and west. Again, we had difficulty in determining how to number branch lines. At that time we failed to reach a conclusion, and after making an estimate of the cost the matter was deferred. It has come up for reconsideration at intervals, and we will have to come to some conclusion soon for two of our divisions which have been very much built over. Whether to number consecutively, as is our present

practice, or go to the decimal system, adopted years ago, is still undecided. Personally I am not as keen now for the decimal numbering as I was ten years ago, and it is largely because our lines are so situated that to carry out that system fully would lead us into some absurdities.

The principal objection to the decimal system of numbering is that it gives no clue to the number of bridges on any particular division, or on the entire system, whereas, the consecutive method does.

After all, I think the numbering of bridges is an arbitrary matter, which we become accustomed to, like any other matter, and when once learned is pretty hard to replace. The merits of the decimal system of numbering are many, but in reality I think are largely theoretical. If the matter were left entirely in my hands I would adhere to the consecutive numbering system.

I. L. Simmons, Bridge Engineer, Rock Island Lines:—The practice on our road at present is to number the bridges according to mile post location. For instance, if a bridge is located at mile post 24.1, we call that bridge No. 241, designating at the same time the division or branch on which it is located. All of our bridges, therefore, have whole numbers, but the bridge record shows their location according to miles and hundredths. We do not number pipe culverts or reinforced concrete culverts.

It is not our plan to use a prefix indicating the various divisions or branches. The bridges on some of the lines taken over by the Rock Island system are designated by a prefix, because such was the practice of those lines, but when the new number boards are put on there will be no prefix. We simply refer to a bridge on a branch line as being, for instance, "Bridge No. 1043, Ardmore Line, Indian Territory division."

A. F. Robinson, Bridge Engineer, Atchison, Topeka & Santa Fe Ry.:—Our old method was to number the bridges consecutively, beginning at one end of the line. Thus, the bridges between Chicago and Kansas City were numbered from 1 to 818, beginning with No. 1 at Chicago. The bridges on the Pekin branch were numbered from 1 upward, No. 1 being the first bridge out from Streator on this branch.

On our Coast Lines we use a letter prefix and the mile: "A15," "B15," "C15," etc. A would designate the first bridge after passing mile post 15. B the second, and so on.

On other portions of the system the letters are used as a suffix, and the bridges after leaving mile post 15 would read "15A," "15B," "15C," etc.. until reaching mile post 16, then would read "16A," "16B," and so on. I like the latter system better than that which is used on the Coast Lines.

G. W. Rear, General Bridge Inspector, Southern Pacific Co.:—In considering this subject, one naturally asks, "Why number the bridges at all?" Is it not a fact that all the larger bridges are commonly known by their names and not by their numbers? Every man on the Southern Pacific knows where Big Cañon trestle is, but it is doubtful if half a dozen know its number. This being the case, it follows that numbers are used mainly to identify the less important structures, and consequently the number should convey some idea as to location. It is doubtful if it is wise to have the number also designate the style of the structure.

There are two styles of numbering which follow out this idea:

1st, Numbering from each mile post, showing mile and hundredths, thus—1234.56.

2nd, Numbering from each mile post, showing mile and a letter, thus—1234A, 1234B, etc.

The decimal system has an advantage in that the distance from the mile post is given and structures can be filled or new ones put in without revising the bridge numbers. The disadvantage is mainly that if a board is lost the section foreman will not be able to tell the exact number. Some one else must then locate the number, and in making an inspection it is not easy to discover omissions. It is also difficult to read a long number, where a railroad has several thousand miles of track. Another disadvantage is that when an engineer finds a small structure riding badly he usually waits until he gets to the next structure and reports the number back from the second one. Mistakes often occur in that way.

The main disadvantage of the letter system is that the numbers have to be changed every time a structure is removed or a new one inserted.

The advantages of the letter system are that the numbers are easily read, it being only necessary to catch the letter; and when boards are lost it is easy to replace or repaint them by referring back to the last number or mile post.

Personally, I recommend that structures be numbered with the mile number, with a letter to designate the order in which opening comes beyond the mile board. The numbers should include all openings through the embankment which terminate on the company's property; also overhead structures which are maintained by the railroad. This method eliminates sewers, water pipes, etc., which are continuous, and overhead structures for which the company is not responsible. I would not number surface or slat cattle guards, but would number pit guards, pipe culverts, etc.

Wherever possible the number should be painted on the structure itself, as on the end post of through bridges and on the bulkhead of trestles and bridges suitably constructed.

A. B. Ilsly, Bridge Engineer, Southern Railway:—On our road the number gives the mile post location, and the letter, which may be either a prefix or a suffix, indicates the line or division. Our main line bridges are numbered without prefix or suffix letters, and in a general way, the bridges on the lines in the east have prefixes, while those in the west have suffixes.

We have more lines than there are letters in the alphabet, and the suffixes and prefixes in these cases are selected without any particular system.

Many of the lines have letters which refer to local names. For instance, the Aiken branch, is designed by the prefix "AB"; Evansville branch by the suffix "EB;" the Middlesboro branch by the suffix "CG," because this line passes through Cumberland Gap.

W. F. Steffens, Engineer of Structures, Boston & Albany R. R.:—The Boston & Albany and the New York Central main line use the consecutive system of numbering bridges. The New York Central tried the mileage basis for a short time and pronounced it a failure. My personal preference has always been for consecutive system coupled with mile post record of it in the office. Perhaps this preference may be prejudice, but our section men and bridge employés were thoroughly disheartened when the mileage system was tried, because it was often a case of remembering five figures, whereas, with the consecutive system, using a prefix to designate the branch from the main line, only two figures, or, at most, three figures, were necessary. Even the stenographers were constantly twisting the decimals in transcribing them in correspondence and records.

W. S. Bouton, Engineer of Bridges, Baltimore & Ohio R. R.:—The practice on the Baltimore & Ohio R. R. has been to number the bridges on each division independently. In general, this numbering has been serial, using the lower numbers for the main line of the division and a separate hundred for the bridges on each branch of the division. In case there is any change of line or of division terminals, which changes the mileage of the division or eliminates one or more bridges, this system permits the dropping out of the numbers without affecting the remaining numbers. Additional bridges are numbered by using fractions. This system of numbering has an advantage where such changes are likely to occur.

Where the mileage of a division is not likely to change, because of revision of line or change of terminals, I believe that the mileage system is the most satisfactory, giving each bridge the number corresponding to mile and tenth of mile, thus showing its location from the terminal. This system has been in use on five divisions of this road for some time, and has recently been extended over a sixth division.

The mileage system of bridge numbering on this road follows the mileage of the division in which it is employed. On the Chicago division, for instance, where the division mileage starts with "O" at Chicago Junction and runs west to Chicago, the first bridge is numbered "$^0\!/_4$," showing that it is 0.4 of a mile west of the division terminal.

On the Indiana and Illinois divisions, which extend from Cincinnati to East St. Louis, the mileage is continuous over the two divisions, starting with "O" at Cincinnati and running to 336 miles at East St. Louis. The first bridge west of Cincinnati on the Indiana division is numbered "1-29." The first bridge on the Illinois division is numbered "170-04," being 0.8 mile west of the Eastern division terminal, which is 16.6 miles west of Cincinnati.

This latter system, however, was in use prior to the absorption of this territory by the Baltimore & Ohio R. R. and the numbering which existed at the time of the absorption has not been disturbed. In extending the use of the mileage system of numbering it is the intention to adhere to the system already adopted on the Chicago division, as mentioned above.

C. H. Cartlidge, Bridge Engineer, Chicago, Burlington & Quincy R. R.:—It is my firm conviction, after some twenty-five years of experience, that the double decimal system of numbering is the best. This involves the presence of mile posts, because the bridge numbers follow the mileage, and the location of bridges and culverts is determined by two places of decimals. This avoids confusion when bridges or culverts are located in close proximity and also makes possible the removal of the bridge without requiring the changing of all the numbers in the mile or the records in the office, except so far as the bridge is concerned.

The fact that a certain number is reported by an officer of a given division is sufficient to identify the bridge. On branches of division in question the system provides for the use of a letter designating the branch, the letter being placed at the beginning of the number. This is not universally used, however, as we have found it sufficient to use the number and designate the branch as well. Of course the ideal way is to use the letter as suggested.

A. E. Killam, Inspector of Bridges & Buildings, Intercolonial Ry. of Canada:—There is some difference of opinion as to the best method of numbering bridges. Some think best to give the number a letter prefix or suffix to designate the various classes of structures.

When I came to the Intercolonial Ry. that road had no system of numbering bridges. After I became acquainted with the state of affairs I adopted a system of my own which gives good satisfaction. I began at the west end of the line and numbered the bridges consecutively to the next station; then started in again with No. 1 and numbered consecutively until the next station was reached, and so on. The mile posts were also noted, and the structures are therefore located both by mile post and station. Sheets were then prepared, numbered consecutively and assembled in book form, making a register which is kept on file in the bridge engineer's office. Each division foreman is furnished with a note book, compiled from this register, for use in making inspection. The register shows the dates of inspection for the last twelve years of each bridge.

A system was devised in the chief engineer's office by a Danish engineer, designating spans by letters, but was not adopted.

John A. Bohland, Bridge Engineer, Great Northern Railway:—Bridges are numbered in numerical order in direction away from St. Paul, except in case of our Duluth line, where the reverse order is used. On branch lines new series are started from junction points. In this way we have several bridges of the same number and it is always necessary, in referring to bridges by number, to give the location or line upon which they occur. We, however, do not find this objectionable, and I consider it good practice, even if the bridge numbers are so arranged as to show the line.

We have considered various systems of numbering, but no action has ever been taken to make the change. For example, we have considered the mileage system with number corresponding to mile post and tenth; and the symbol system with the letter to indicate the line. I consider the mile-post system a good one, but this is again complicated by branch lines, which would require symbols.

F. L. Thompson, Engineer B. & B., Illinois Central R. R.:—The scheme used for numbering bridges on this road is known as the mileage system. On the main line, from Chicago to New Orleans, bridges are numbered be-

ginning with zero at Chicago and running to 912 at New Orleans. Any bridge on a given mile has the mile number, then a dash, and after the dash the nearest hundredth of a mile at which the bridge is located. For example, a bridge one-half mile south of Mile-Post 250 would be written "250—50." No prefix is used on the line from Chicago to New Orleans. Other main lines and branches have the same letter prefix as that used by the transportation department in the location of stations. By the use of this system, when the number of a bridge is given, its exact location should be readily determined.

E. B. Ashby, Chief Engineer, Lehigh Valley R. R.:—Our present practice is to number bridges in accordance with the mile within which they are located. For instance, the first bridge on Mile 130 would be numbered "130;" the second, "130-A;" the third, "130-B." The culverts and pipes are numbered in a similar manner, and to distinguish them from the bridges, a cipher is placed in front of the number. All openings above five feet clear span are called bridges; all openings below five feet clear span are called culverts.

For branch lines, to avoid duplication of numbers, an initial is prefixed to the numbers; for instance, for the Flemington branch the letter "F" precedes the number.

We think very well of numbering bridges according to the mile and decimal parts of a mile. For instance, bridge No. 100.05; No. 100.2, etc., and we are now looking into this manner of numbering.

H. Ibsen, Bridge Engineer, New York Central Lines:—In my opinion the best method is to number the bridges according to the mileage, locating the bridge to the nearest hundredth of a mile, taking the mileage as running from the starting point of each division. For example: Our main line numbering runs from Detroit to Chicago and from Detroit to Buffalo. Our numbering on branches runs according to the mileage from the main line diversion point.

Up to about 1898, we used the consecutive method of numbering on our road, giving each bridge a consecutive number starting from division headquarters. We found this unsatisfactory, as we often had to put in new openings and then had to use half numbers or renumber our bridges entirely. Numbering by mileage leads to no trouble in this respect, and we find it much easier to locate a bridge definitely, so that everybody can find it when work is ordered, or when slow orders are requested for any reason. The numbering, however, exists only on paper and in our records.

We have several times contemplated getting up numbers to put at our bridges, but so far it has been considered to be too expensive, and has been put off until some other time, except as to stenciling the mileage on the bond timber or guard rail of wooden bridges, and on the side of steel bridges when they are being painted.

C. E. Smith, Bridge Engineer, Missouri Pacific Ry.:—The present practice on our line is very unsatisfactory, the bridges being numbered from one up, on the individual lines, the numbers being the same as those given the bridges when the lines were originally built. There are many bridges having the same number on each division, and they must be identified by referring to the lines on which they are located.

I have not been able to arrive at a satisfactory method of numbering bridges on railroads having many divisions or branch lines, but I presume some system of mile-post numbering could be worked out that would be satisfactory.

A. W. Carpenter, Engineer of Structures, New York Central & Hudson River R. R.:—We tried at one time to adopt the mileage system of numbering bridges but found it unsatisfactory for the following reasons:

1st: It made great confusion in our records, the bridges having been numbered consecutively and no changes having been made in the numbering for many years.

2nd: The mileage system was found to be changeable, varying with any change in the length of line caused by change in alinement. For instance, we built a cut-off at a point near New York City which shortened the line three-quarters of a mile. This changed all the mileage on the main line between this point and Buffalo practically the entire length.

I believe personally in the consecutive system of numbering as being the most satisfactory.

Openings four feet and under, of any character have no number, unless a regular consecutive number now exists for them, in which event this regular consecutive number is maintained. Where the present number may be a sub-number, as "A-1a," the number can be dropped. Where there are openings over four feet which at present have no number they can be given a sub-number, as A-1a.

All pipes, box culverts, small arches and other openings under four feet are scheduled by showing their relative position and mile post location, but they are not given a number.

W. H. Moore, Engineer of Bridges, New York, New Haven & Hartford R. R.:—The system of numbering bridges—whether railroad or overhead—on the New Haven Line, is the mileage system, the zero point being taken at the commencement of each division or branch and numbering the bridges consecutively in accordance with their distance, in miles and hundredths of a mile.

Before this system was adopted there was no uniformity of numbering on the different properties which were absorbed to make the New Haven road as it now exists, and this led to great confusion. We have found that the uniform numbering by mileage works out very well, and is perfectly elastic. The number locates the bridge, making it very convenient for men sent out to examine any particular structure.

R. H. Reid, Supervisor of Bridges, Lake Shore & Michigan Southern Ry.:—The system which we now have in use on this road is the old-fashioned one of consecutive numbering, starting from one end of the division, or branch,—generally the west end of main-line divisions and the end of branches where they connect with the main line. One difficulty in this system of numbering is that when new structures are built between the older ones, fractional numbers are introduced which in some cases get very numerous and rather lead to confusion; and also, if any of the regular structures are abandoned the number has to be carried along with the statement that the structure has been abandoned, in order to keep the consecutive numbers. This system of numbering does not show the location of the bridge from either end of the branch, and does not indicate to train dispatchers or superintendents just where the structures are.

A better system, which we are gradually introducing on our lines, and have already in use on two of our branches, is what we call the mileage system of numbering, that is, giving each structure a number which shows its distance in miles and hundredths from some definite point; in the case of the two branches the distance being from their main line connection. One of the advantages of this system is that any one hearing a bridge or culvert number knows just where it is located. Also, if a new structure is built, its location automatically determines its number.

There are other systems of numbering, one of which is the mile and letter system, viz.: all bridges in the first mile would be as follows: "1-A;" "1-B;" "1-C;" "1-D," etc.; in the second mile, "2-A;" "2-B," etc. Any extra structures built between existing structures, would necessarily have fractional numbers with this system, and I do not think it is as good as either of those which we have in use. I consider the mileage system of numbers the best, taking everything into conisderation.

On the main line the mileage can be calculated from one end of the line or from one end of a division, but, preferably, on ordinary railroads, from one end of the line. On branches, the mileage can be calculated from the point where the branch leaves the main line, or, if desirable, from the other end of the branch, although I prefer the former.

As additional structures may be required on account of track elevation, separation of grades for highways and other purposes, there is always a number available for them without having to use fractions. The numbers should show the mile and hundredths. In this way structures 53 feet or more apart will have definite numbers, and it is rarelv that bridge structures or culverts are nearer together than this.

We have three branches numbered with miles and hundredths, the remainder of the line being numbered in the old-fashioned way with consecutive numbers, but we are in hope of gradually changing from these to the mileage system. The great difficulty in our case is that all of our structures for years back have been carried on our account books and on the auditor's books under the old numbers, and a change to new numbers of any kind on a road as old as this is quite a serious matter. This makes it the more essential to start right on new roads and new branches.

J. E. Crawford, Bridge Engineer, Norfolk & Western Ry.:—The system used on this road is to start at one terminal on the main line and number bridges straight through to the other terminal. Each branch is given a separate series of numbers, and allowance is made for possible extensions. If it becomes necessary at a later date to place undercrossings or other additional bridges between any two bridges, the new bridge is given the number of the one next to it, with the addition of a letter. We find this system to be satisfactory.

About ten years ago the Association of Railway Superintendents of Bridges and Buildings, of which our general bridge inspector is a member, threshed over this question of bridge numbers very thoroughly, and decided that the system which we are using was the most satisfactory one.

An alternative method is to number the bridges by mile-post location. This method is open to objection owing to the many duplications of numbers and because it is necessary to prefix a letter or name to denote the branch or division.

H. E. Stevens, Bridge Engineer, Northern Pacific Ry.:—I am sorry to say that the system of numbering bridges on this road is far from being a model one. At the time the line was built the system followed was to number all bridges consecutively, beginning with number one at the east end of each division. The culverts took the number of the next bridge east of them with an alphabetical suffix.

We have cases where culverts between two bridges run clear through the alphabet and start in again "A" and a numerical suffix. As time passed and division points were changed, new divisions added, and bridges were filled and new bridges put in, timber bridges replaced with culverts, etc., the system of numbering finally became so involved that it was difficult to locate a bridge by the number unless some other information was added.

Some years ago, therefore, it was decided to renumber the bridges, and a system based on the mile posts was adopted. Under this system a bridge takes the number of the next mile post east, a decimal and number being added to indicate the number of the bridge in particular. For instance, the third bridge between mile posts 132 and 133 would be numbered 132.3. Culverts are not taken into account in the numbering. This system was put into force on three or four divisions, but was found objectionable because of the difficulty of numbering a bridge when one was placed between two existing bridges; also when a bridge was filled and replaced with a culvert its number under this system would disappear. Notwithstanding, it is a great improvement over the old system.

In my opinion, bridges should be numbered with reference to the easterly mile post, plus the number of hundreds of feet it lies west of said mile post. The number should be written in a circle with the mile post number on the upper half and the number of hundreds of feet on the lower half, with a horizontal line between.

P. B. Motley, Engineer of Bridges, Canadian Pacific Ry.:—I have to state that our bridges are always numbered according to mileage, and the mileage is based on engine runs called "subdivisions" which are in turn parts of divisions.

J. B. Maddock, Engineer B. & B., Central of Georgia Ry.:—Where there is more than one bridge to a tenth of a mile the nearest hundredth should also be used. We do not mark the designation of branch lines on the number block of bridge, but specify it in reports as "A&B" line or "C&D" line.

C. Chandler, Engineer B. & B., Chicago Great Western R. R.:—The advantage of the mile and decimal numbering system is that an employé of the road is ordinarily familiar with the location by miles from some given point, and on seeing the mile number on the bridge immediately associates this bridge with a certain place, the distance of which from Chicago is known. It also enables one, in case of a telegraphic report of an accident by fire or otherwise, to immediately locate the point at which the accident occurred without having to refer to any other data than the nearest town to the bridge number by mile. This system of numbering is used by the C. G. W. R. R.

L. D. Hadwen, Engineer Masonry Construction, C. M. & St. P. Ry.:—On our line bridges and culverts are designated by numbers, having a letter prefixed indicating the division on which they are located; the bridges being designated by even numbers and culverts by odd numbers. The numbering on each division runs westward, time card directions being followed; the first bridge being designated as No. 2 and the first culvert as No. 1. These numbers are assigned to the structures on completion of a line, and additional bridges or culverts that are built later are given fractional numbers showing their position relative to the older structures. Both main line and branches have the same prefix letter and on the Chicago, Milwaukee & Puget Sound line double letters are used to avoid confusion with those on the parent line.

While the above method has its objections, in that it does not locate the position of the structure as is done in a decimal system where the number shows time card location of the structure, yet, on account of the labor involved in the change on over 9,000 miles of track, it has been considered inexpedient to adopt a new method.

The number boards used by us heretofore have been attached to ends of bridges. Small boards nailed horizontally to the right-of-way fence post adjacent to the ends of culverts are used for this class of opening.

Personally, I consider that a system of numbering which designates the location of a bridge with reference to its actual position on the profile is most desirable, especially if used with a letter prefix for each division. It is increasingly difficult to separate openings under track into bridges and culverts, for many structures might be considered as belonging to either class; moreover, bridges are continually being replaced with culverts. This fact makes it desirable to have the openings numbered without reference to their character and entirely by their location.

A. E. Deal, Bridge Engineer, Delaware, Lackawanna & Western R. R.:—In cases where we have bridges coming close together, on different branches, at the same mile post, it is understood that when reports are made regarding these bridges they are to state whether the bridge is on the main line, or if on a division, and the name of the division.

J. G. Gwyn, Chief Engineer, Denver & Rio Grande R. R.:—I would advise that if a new bridge opening should be created on our main line between mile post 274-A and 274-B it would necessitate renumbering of all the bridges between the new structure and mile post 275.

While it is possible to get along without the suffixes "E," "W" and "S" for bridges on double track and sidings, I nevertheless regard them as essential. It is easy enough in describing a bridge in correspondence to state whether it is on a siding, or on which main track it is located, yet, I feel that each bridge should have a distinct number. It is partially, therefore, due to the facility of adding these letters to the number plate on the bridge that we adhere to the practice.

I am also of the opinion that these suffixes eliminate considerable confusion and discrepancy in bridge and building foremen reporting work on their monthly job lists, for, with the system as we have it, it is almost impossible for work reports or records to come to us without definite information as to just which structure is meant.

This system has been in use on our lines for many years, and while it is possible, perhaps, to devise some other system which will answer equally well, yet, I do not believe there is one which is better for practical purposes in keeping clear, concise and comprehensive records of our bridges.

W. H. Wilkinson, Inspector of Bridges, Erie R. R.:—The simplest way to designate bridges is to number them consecutively from one up, for each division, but this has its drawbacks, particularly when an opening is filled, or a new one installed, etc. In addition, this system does not permit of readily locating a bridge unless the nearest station is shown.

In my opinion, the best method is that in which bridges are numbered according to mile post location. For instance, if a bridge is located three-quarters of a mile west of mile post 300, on blank division, the number would be 300.75. While it would be more desirable to show the numbering to the nearest tenth, this does not in some cases permit of an accurate location where bridges exist close together; and for this reason hundredths should be used. Numbers should be stenciled on the nearest telegraph pole, or on the structure.

This system is in vogue on the Erie Railroad and is giving satisfaction, particularly for locating structures in the field. Some definite arrangement, such as considering the east or west end of a bridge in numbering, should be decided upon, on account of the great length of some structures. Such a system is perfectly elastic, and, in conjunction with the time table, gives a ready means of accurately locating any bridge. For branch lines, the mile posts usually begin at the junction with the main line, and the system is thus applicable to all cases.

There is only one instance where there would be ambiguity, and that is in case of a revision in alinement, where the old line is kept in use. In such a case, of course, if the mile posts start at the junction point on the cut-off, they would not coincide with the old line mile post where the cut-off again joins the same. This difficulty can be overcome by installing the mile posts as in branch lines, and then going back to the main line mileage where the cut-off again joins the main system. In all the above-mentioned systems it is necessary, of course, to state the number and the division, particularly in the case of branch lines and cut-offs, as will be evident.

J. M. Staten, General Inspector of Bridges, Chesapeake & Ohio Ry.:—I am still of the same opinion as when I made a report on this subject in 1895. We put numbers only on openings of ten feet and over. We never number anything like a box or arch culvert, no matter what the length may be. Number blocks have numbers on each side, which shows the same from each direction. Ten bridges may be on a territory covering one mile, and if one of these should be dispensed with it will not affect the remainder, or if a new opening be created within the mile, the fraction of a mile will designate it. This is a big advantage over the old conventional way of numbering. I don't know the actual cost of number blocks, but they are not expensive. I must emphatically denounce the numbering of all waterways. This seems utterly useless to me. All railroads are endeavoring to fill openings of less than ten feet, by using old iron and scraps of steel rail, and ballasting over them so that they are then looked after by the section men, who are responsible for them when they cease to be bridges.

Howard G. Kelley, Chief Engineer, Grand Trunk Ry. System:—This company is following its old practice of numbering bridges consecutively, without regard to mileage, and where additional bridges or openings are constructed they are designated by the letters "A," "B," etc.

Personally, I believe the best method of numbering bridges is by mileage and tenths, without necessarily complicating the reading on the number board by the insertion of any letter or other designated mark for the division or district in which it occurs. Ordinarily, on a large system, no man can carry in his mind all of the letters which designate a division or district, nor can he remember the various bridges by number, except the most important ones.

The designation by mileage and tenths immediately places the location of the bridge clearly in one's mind, and the report in an emergency case with respect to any particular bridge would designate the division or district upon which it is located.

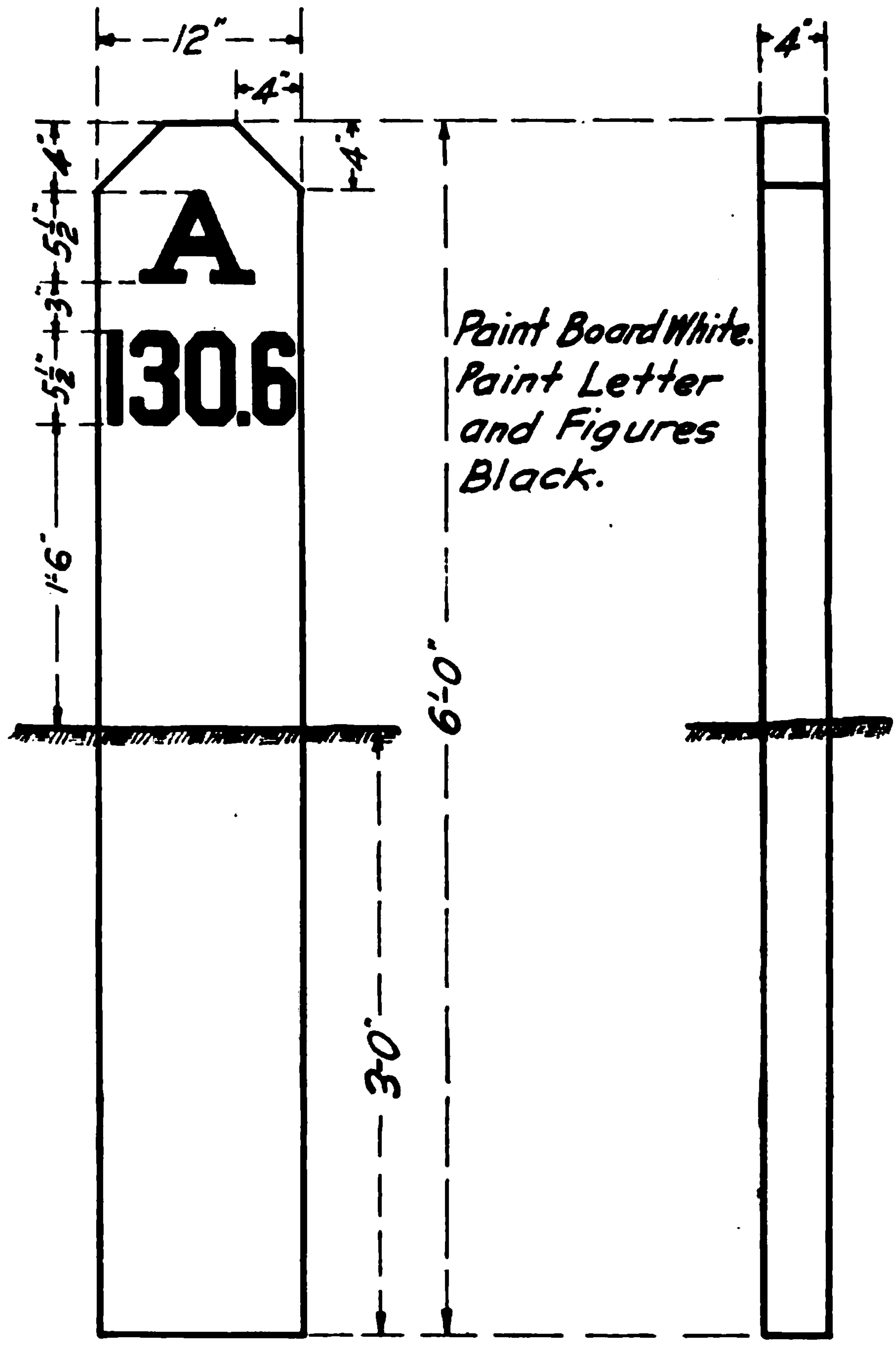
Wm. Graham, Civil Engineer, Baltimore:—If the conditions on a railway regarding bridges were to remain stationary for long periods of time,

probably the best and simplest system would be straight consecutive numbers. This stationary condition, however, practically never obtains. The typical railway is in a continual state of evolution, due to changes in alinement and grade, replacement of temporary by permanent structures, diversion of streams, new railway crossings, both electric and steam; opening of streets, highways and private crossings; elimination of grade crossings; track elevation and depression; new industrial crossings; new navigation, drainage canals, etc. These changing conditions are best met by the mileage system of numbering bridges and other structures.

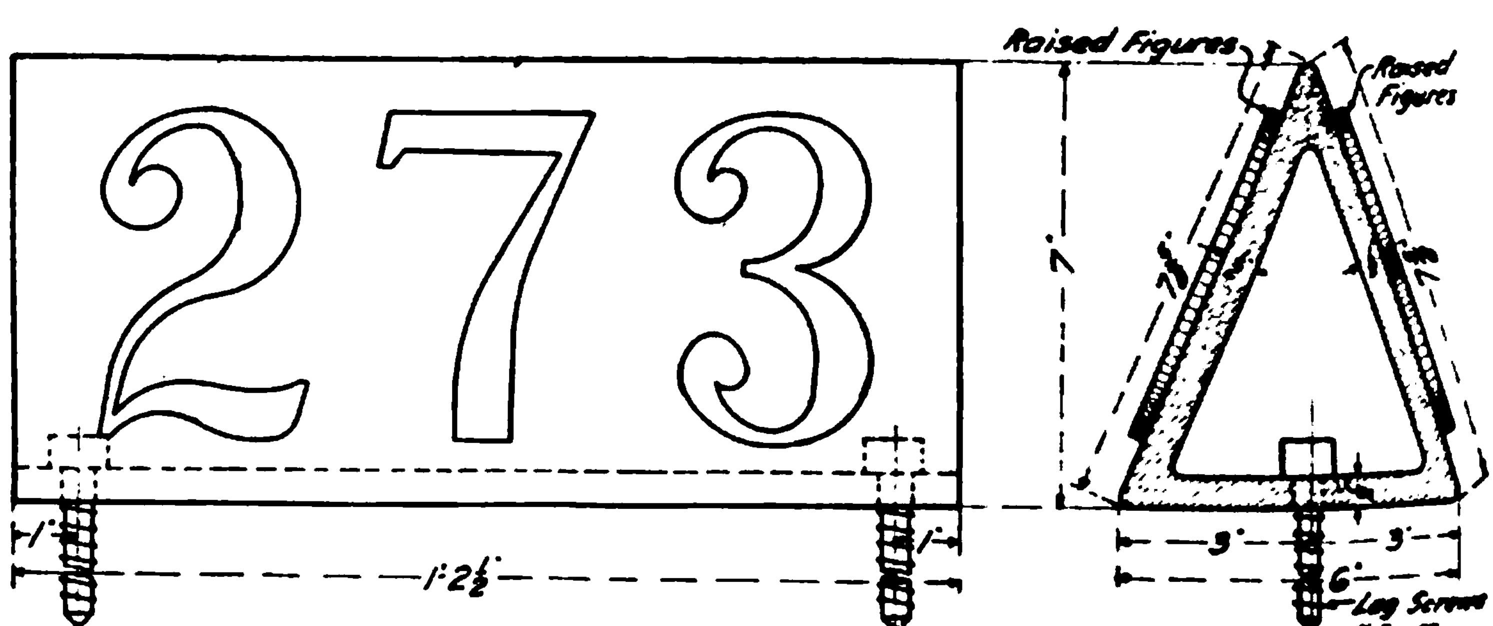
The mileage system, however, like all good things, is not without its faults. One difficulty is the lack of permanency in the location and marking of mile posts. If the location of the mile post is changed, it necessitates a change in bridge numbers and leads to confusion in the records. Mile posts once established should be permanently and substantially marked and thereafter regarded as permanent reference points not to be changed, except for very good reasons, long intervals of time, say a generation or two.

Another difficulty is the hair splitter, who is constantly finding slight changes to make in mileage numbers to get them just right. It has been customary in giving numbers to use the mileage of the "near" end of the bridge. It would be better to use the mileage of the center of the crossing, such as the center of the channel of the stream, the center of the street, or the center of the railway crossing; this, because the approaches to a bridge are often of a temporary nature and liable to be filled or shortened; or, a long trestle may be filled, leaving several openings which require individual numbers. In the latter case, the main bridge would retain the original number. Mileage numbers should be carried through main lines from end to end. On branches, the mileage should begin at point of junction with the main line. On short branches and spurs the bridges can be given the junction mileage, with sub-letters, as "79.4A;" "79.4B," etc. At junctions the initial point for branch line mileage should be the head block of the junction switch. The junction station is frequently located in the crotch, and if the station is the initial point it may result in minus mileage for structures between the switch and the station.

I. F. Stern,
R. H. Reid,
E. B. Ashby,
Wm. Graham,
Committee.



Southern Ry., Standard Bridge Number Board.



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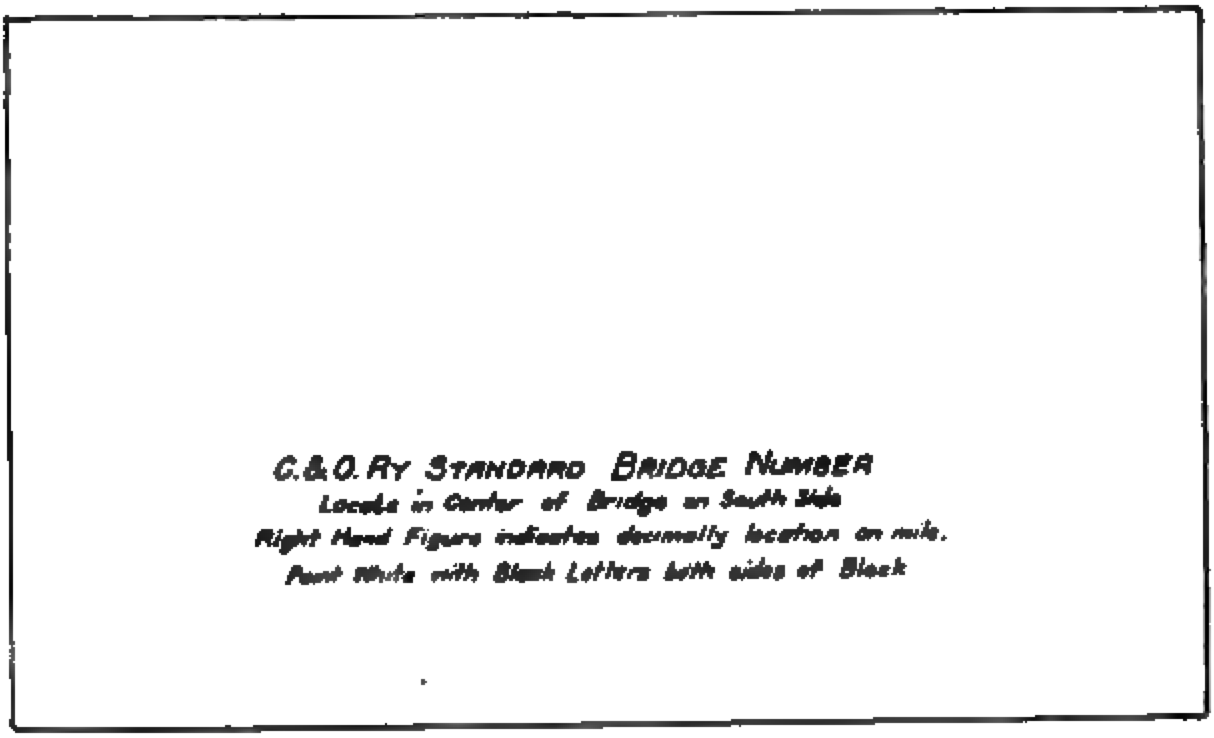

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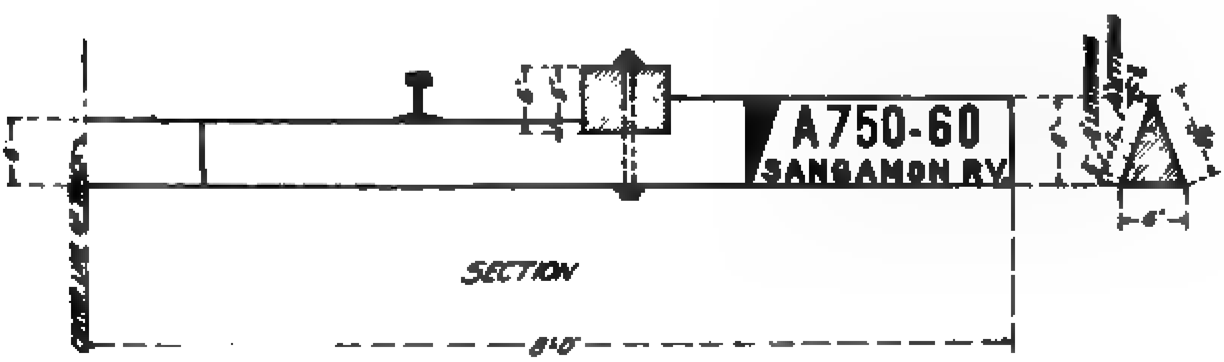

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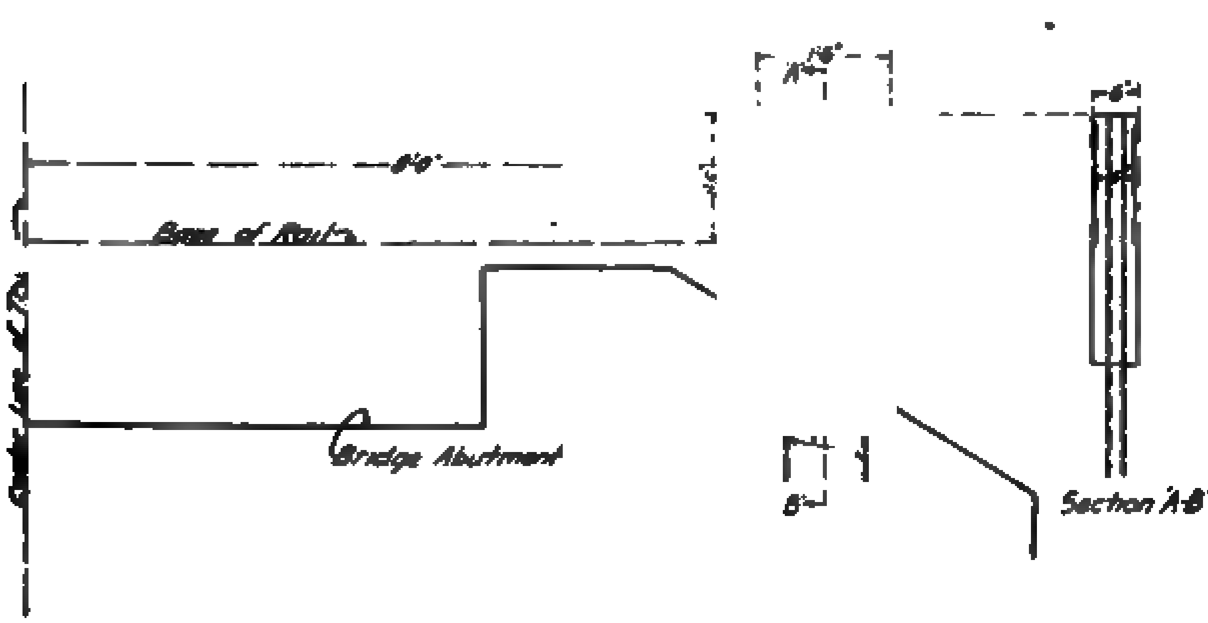


DISCUSSION.

Mr. Moore, New York, New Haven & Hartford R. R.:—Within a few years we changed over from the consecutive system to mileage numbering, believing it to be a great advantage in locating the structures. In compiling our new books we used two parallel columns, one giving the old number of the bridge, and the other its new number. The stations are also numbered on the mileage system, so that we immediately know how far the bridge is from the nearest station. We place a zero point arbitrarily at the beginning of each branch and number from there to the end of the branch. There was a good deal of argument against this method of renumbering when first the matter was brought up. Those who opposed it contended that it would make endless confusion; that our people, having been accustomed so long to the old way of numbering, would not readily locate the bridges by the new system, but we found that was not so. Within six months everybody was well pleased with the change. No confusion arose at all. Having tried the milage system for about four years we would not think of changing to any other plan that we know of.

The President:—Will you please state how you manage the numbering of branches nearly parallel with the main line? How do you distinguish the milage numbering on one branch from that of another?

Mr. Moore:—Each branch is given a name.

Mr. Staten:—We have used the mileage system for numbering bridges on the Chesapeake & Ohio for twenty-two years. It is as easy to number them on the branches as anywhere, for the branches are provided with mile posts, and each branch is designated by a name. If a bridge is filled we discard the number block or repaint it and use it elsewhere; if a bridge is added we designate it by the mile and tenth corresponding to its location. We have about twenty different branches, but we find no difficulty in locating any bridge on any one of them.

Mr. Swartz:—We have a system of numbering our bridges and culverts on the Grand Trunk Ry., which we think is pretty hard to beat. Our system is divided up into divisions and the divisions are subdivided into districts. The bridges are numbered according to the mileage system. I brought one of our books with me and will pass it around if any one cares to look at it.

Mr. Andrews:—I want to say that, personally, until the last year or so, I have always been in favor of the mileage system of numbering. During the past year or so we have made a number of changes in our line, that is, in some places shortened it, and in many places cut out existing structures, and it has unquestionably caused confusion in the original numbering. Originally our road was numbered consecutively, in sections to the Ohio river, beginning in the year 1828 and completed in the year 1857. You see it took several generations to decide on the numbers to be placed on the bridges. I want to say here that I was not one of the original generation. However, that part of the road is today numbered consecutively on the main line and on the branches which now form part of the main line. On other parts of our road bridges are numbered by the mileage system. For example, let us consider the line from Baltimore to Philadelphia: Since that was built the mileage has been changed. The original terminal was cut out and the belt line put in, which increased the mileage at that point about four miles; so the original numbers, while based on the mileage system do not now correspond to the revised mileage. They were numbered in this way; the first bridge we will say was in the tenth mile, that bridge was known as 10-A. If there was another bridge in that mile, it was known as 10-B and so on, until we got beyond the mile; then we commenced with 11-A.

But since that time, the method that has found the most favor with our people is to take each division separately, starting with No. 1 on the main. line and continuing through with consecutive numbers to the terminal point of the main line of that division. The first branch would be in the two hundreds; the second branch would be in the three hundreds; and so on up.

Every bridge that we have over a 6 ft. span is charted and placed in a folio with the bridge number, the name of the stream, the nearest station east of the bridge, and the telegraph pole at or nearest the bridge, every fifth telegraph pole being numbered by the mileage system. By doing that we find that we get better results, with less confusion, and we can tell from our chart the exact location of the structure.

We have another line which was acquired by our company in late years that is numbered by a mileage system that is rather confusing to everybody except those who are familiar with the division, and that is in this way: We will say that bridge 1728 means a bridge in the 172nd mile. By that system with bridges that have four numbers, the first three numbers will be the full mileage and

the fourth number will be the decimal part of the mile at which the bridge is located. With bridges having three numbers, the first two figures will be the full mileage and the third figure will be the tenth, so that bridge No. 128 will be eight tenths of a mile beyond mile post 12. That is a very good system, because new bridges put in between two others need only to have the fraction of the mile added to them.

But I have to say that even though I have always been in favor of the mileage system, the one that now finds most favor with our company is in numbering by the hundreds; that is, the main line commences with one and goes up to one hundred; and if we run over one hundred, the first branch would have to be in the three hundreds; and in that case we begin with three hundred. But where we have less than one hundred bridges on the main line the first branch starts with two hundred and we always know immediately on what branch a bridge is located.

Mr. Schall:—On the Lehigh Valley R. R., bridges are numbered according to the location in miles from New York. For the branch lines a letter denoting the branch line is prefixed to the number. On the main line bridges are numbered according to the mile in which they are located; for instance, with bridges between mile posts 12 and 13, the first bridge receives the number 12, the second 12A, the third 12B, etc. For branch lines the same system is followed except that a letter is prefixed to the number; for instance, on the Perth Amboy branch, bridges are numbered according to the distance from New York; thus bridges between mile posts 20 and 21 would receive the numbers P. 20, P. 20A, P. 20B, etc. For openings of less than 5 ft. box culverts and pipes the same system of numbering is used, except that a cipher is placed in front of the number.

I find that this system of numbering is not entirely satisfactory as it does not provide for the introduction of other bridges without changing the letters designating other bridges in the same mile.

The decimal mileage system of numbering is very elastic and provides for adding other bridges. The bridges would be numbered 12, 12.12, 12.18, 12.45, etc. By using hundredths it will allow bridges to be placed within about 53 feet, whereas if only tenths were used the interval would be about 530 feet. The latter space is too large and some interference in the numbering system on that basis would have to be expected. When a bridge is taken out and abandoned we leave the number vacant. If a bridge is added it would be say 12A½ or 12A¾, etc., as the case may be. I am strongly in

favor of the numbering of bridges according to miles and fractions of a mile expressed in hundredths.

Mr. Killam:—The matter pertaining to bridge numbering is something that I have given considerable attention. When I came to the Intercolonial Railway, in 1887, I was instructed to go out and inspect the bridges and buildings on the line. I went out over the road the first year with a young engineer. We made a record of all bridge structures, but when we compared our notes with the records in the office we found the latter incomplete. We compiled a new set of books giving details concerning each structure, which is explained in the committee report. It will be useless, therefore to repeat it here.

Mr. Pickering:—I am looking for a Moses to lead me out of the wilderness but he has not yet appeared. The numbering of bridges is a vital question with me. I have a territory between Boston and Portland that has two main lines practically parallel. They were originally two separate divisions and the bridges were numbered consecutively on each. I may get a telegraphic report, we will say, for instance, that overhead bridge No. 95 has a broken plank. How am I to know which one of these lines it is on? There is a bridge numbered 95 on the Dover route, also one of the same number on the Portsmouth route; then, to make it more complex, there are about forty branches from the two main lines and one at least of those branches is between the two lines. The other branches interlace, so that they run in all directions. I wish to learn of a system of numbering which is simple and yet so practical that, when a telegraphic report is received concerning any bridge on the division requiring attention, it can be readily and accurately located. I consider that it would not be practical with the mileage system, and I am certain that we do not get the desired result by the use of consecutive numbering. The latter system is objectionable when it comes to adding new bridges, while that is not the case concerning the former. With the consecutive system, additional bridges would require a letter or fractional suffix, and these are objectionable for the reason that the suffix is liable to be omitted in a telegraphic report.

Mr. Andrews:—If Mr. Pickering has two main lines so far apart that they can not be classed as double-track he can certainly take one of the lines and begin with No. 1. Suppose, for instance, that that line would have 275 bridges. Then begin the other line with No. 301. That line ended with No. 475, then begin on the first branch with 501, and so on. In that way there will be no con-

fusion because no two branches on the division will be numbered alike.

Mr. Smith (Mo. Pac. Ry.) :—Anyone here connected with a railroad system that extends over a large territory, such as the Missouri Pacific and the Iron Mountain, is up against it for a numbering system, as Mr. Pickering suggests. The most satisfactory system I have found is that given to the bridges on the St. Louis, Iron Mountain and Southern Ry. When that system was not so large as at present the bridges were numbered from 1 to 778 at Texarkana. Then they started in at a branch point the next number above ten. For example the last bridge on the main line to Texarkana was No. 778; then the first bridge on the first branch line would be No. 781. If we get telegraphic report of trouble at bridge No. 1062, we know it is on the Cairo branch. I give you that as an example. It is feasible to take any division of our system, of which we have eighteen, and on none of them would we need have more than three figures. We need not go higher than 999 on any one division, although we have 10,000 bridges on the system.

The only drawback to this method is the fact that if a bridge is eliminated, the consecutive numbering breaks; if bridges are added, letters must be given them. If two or three bridges are added between bridges No. 620 and No. 621 they could be designated as 620A, 620B, etc. Again, suppose a bridge was to be added between 620A and 620B, I do not see any objection to renumbering them in such a way as to make the alphabetical suffixes come in regular order, to avoid the use of fractions.

We have a place in Louisiana on our lines where there are twenty bridges in one section, and the letter suffixes run up to T. They are all bridges and are numbered from 72-A to 72-T. It is in a rice country, where there are many flumes under the track. As those bridges were put in the letters were changed as described above. It does not follow that they were constructed in the order of A, B, C, etc., as numbered, but we changed the letters in the way I have stated. I do not see how the mileage or decimal system is going to overcome this objection—two objections, in fact—first, littering up telegrams with the name of a station in every case, and in some instances it will be necessary to say east or west or north or south of a station. Near a junction from which several lines radiate there may be the same, or nearly the same mileage numbers in several directions. Again, we might have a bridge at a mile post 1912 and another one at 191.20. The telegraph operator will frequently leave out the decimal point and he will invariably leave off

the cipher in which case they would appear the same. The only way to be certain when using that system would be to refer to the nearest station. If the bridges on any one division are numbered consecutively it is simply necessary to state the number of any bridge, when it can be readily located.

Mr. Andrews:—I do not believe that the principle which I submitted is understood yet. The gentleman seems to think we have to number the entire system consecutively. I did not intend to convey that impression at all. I think I stated clearly that we number each division separately, beginning on each division with No. 1.

Mr. Jutton:—Mr. Smith has stated that in the consecutive numbering system when a new opening is made and a bridge put in, as, for instance, between numbers 72 and 73, the new bridge should be numbered 72-A, and if more bridges are inserted between bridges 72 and 73 other letters could be used. I believe that trouble would ensue in such a case if a bridge were inserted between Nos. 72 and 72-A. It would be rather difficult to assign a number to such a bridge without confusion unless 72-A were changed.

I think fractions are better than letters, under such conditions, as their sub-division is practically unlimited, i. e., a fraction can always be inserted between two other frcations. On one line of road which I have in mind when construction was completed only the open bridges were given numbers; none of the culverts was numbered. It was afterwards decided to number the culverts by the use of fractions, and we now find fractions in use with the denominators as large as 21sts. If letters had been used in numbering these culverts I think a great deal of trouble and confusion would have been encountered. Of course, where letters and fractions are used in connection with the whole numbers there is the danger that in writing letters or sending telegrams about such bridges the suffixes might be left off, but this is a difficulty that we would have to contend with.

Mr. Smith suggested that if a new bridge were inserted between bridges 72 and 72-A the new bridge could be given number 72-A and the other bridge could be numbered 72-B, but it is a serious thing to change the number of a bridge, especially if the bridge has had a number for a long time. The correspondence and all the records concerning that bridge would have to be changed, and it would be very easy to overlook something in doing that.

One of the points urged in favor of the mileage system is that a bridge is located by its number, but I question the value of this feature. If, with this system of numbering, a bridge was reported

a comparatively few local men could readily give its location, but I doubt if many of the operating officials and general officers would stop to figure out the location of the bridge from its number corresponding to the mileage. They would go to the bridge record in their office to determine the location just as they would do with the consecutive numbering system. Then again, the men who would know the location of the bridge according to its number under the mileage system would probably have the same knowledge of the bridge under the consecutive numbering system, because they are men who are familiar with the location of the bridges, and when given the bridge number would know the location of the bridge no matter which system of numbering is used; hence I do not see that this point is a very strong one in favor of the mileage system. It seems to me that a great fault of the mileage system is the large numbers especially where there are so many branches, each of which would have to be indicated by a distinctive letter or name.

Mr. Shedd:—I would like to add a few words to Mr. Jutton's remarks in advocating the use of fractions instead of letters. I believe that fractions should be used when new openings are established in the main line and letters used for spur tracks; i. e., if a spur is constructed between bridges 72 and 73, say two miles long, the bridges and culverts on that spur should be numbered 72-A, 72-B, etc. In this way a bridge number having a letter suffix will indicate that the bridge is on a spur track. This would not apply to the more important branch lines, for which a system of numbering was suggested by Mr. Andrews.

Mr. J. H. Markley:—On our line each station is given a prefix letter corresponding to the division of the main line or the branch on which it is located. Our bridges are numbered in the same manner. I do not see how confusion can arise from that method.

Mr. McNab:—The Pere Marquette road adopted the mileage system over twenty years ago and we have never had any confusion resulting from it. The main line extends from Chicago to Petoskey, and on that we have the straight mileage system. The stations also are designated by the mileage system in the same book. Bridges on branch lines are given a letter prefix. Examples are: A13.4, B57.8, D76.4, etc. Every foreman has a small blue print book that he carries in his pocket, showing the location of all bridges in his territory. The dispatcher in the office also has a book of the same kind, so that if any one reports a bridge it can be located at once. We had a resurvey made and station stakes set every 500 feet. Every stake is numbered according to its station, which makes it

a very easy matter to locate bridges and other structures. We have also a small blue print book which gives the station numbers and shows the culverts, their size and kind so that when anything occurs it is very easy to refer to that book, and in a moment one can tell all about it.

Mr. Pickering:—I know of a case in point in regard to Mr. Jutton's suggestion of the use of fractions to designate bridges. In the City of Lynn, we have, or will have, when the elevation is completed something like eight bridges between numbers 13 and 14, and No. 14 has been abandoned; hence you can see that it is going to be very confusing, because on the other main line we have Nos. 13-A, 13-B, and 13-C at the present time.

The system that I had suggested was the decimal mileage system, starting with one main line at 100 and the other main line at 200, and each branch starting from the Boston terminal with A, B and C, prefixing the letter before the number. As yet I have not heard of anything here today that pleases me any better than that. I do not like the consecutive numbering system because it is confusing to add new numbers.

It is a serious thing to change numbers on our bridges, and it is also very confusing if we have several bridges bearing numbers that differ only by a letter or fractional suffix; we are likely to experience trouble in telegraphic reports, for they will occasionally be omitted.

Mr. Smith:—The system recommended by Mr. Pickering would not do on our roads. We have on our line no mile posts except telegraph poles. The nearest telegraph pole to any mile is painted white for about ten feet of its length and the mile number is painted on that. Every fifth pole is painted white for a short vertical distance and on the pole is painted the mile number in a horizontal line and below that the number of the pole, and by that means the bridges are located. The distance between poles then becomes the unit of measurement. Our bridges have come to be known by the pole reference. Enginemen going over the road wishing to refer to a bridge, catch the nearest mile post and then add the number of poles to the place where the bridge is located.

If the bridges were numbered by a separate system of mileage from that used by the telegraph poles on the line, it would be confusing. On the other hand it is not possible for us to follow out any definite system of numbering on our road, because our system is not numbered consistently with those mile posts. There are some through lines that have now become main lines of traffic that were

originally composed of four or five different companies. The mile posts on those lines, for counting purposes, start at zero, where construction commenced, and run up to the highest number. In some cases we have four or five sets of mile posts on such lines.

Mr. Aldrich:—As Mr. Moore has said, our road has the mileage system of numbering. When we first began to use it I thought it a pretty poor system, but the more I use it the better I like it. Every man knows his own territory. If we get a message that a train reports a certain bridge as being out of order, we simply refer to a time card to locate it. If we are in doubt as to which particular branch it is on the number of the train reporting it will assist in locating it. If one has a time card he virtually has a list of the bridges. I think it is a very simple matter. There are some sixteen branches on the territory that I cover, and I never yet have had a report of a bridge that I could not locate by putting my hand in my pocket and taking out a time card. I think that mileage numbering is the best system that has been suggested for our lines. We have some bridges that have been added to about the same territory that Mr. Pickering spoke of, on what we call the Harrison elimination. It is very easy to number those bridges by the mileage system.

Mr. A. S. Markley:—We have used the mileage system as well as that of numbering by telegraph poles. We have concrete posts for our mile posts. We then numbered every fifth telegraph pole, but the number of telegraph poles per mile has been changed from thirty to forty-two, generally while in some places we have thirty-five. If the poles were all set at like distances they would lend themselves to the simplest method of locating bridges that I know of.

Mr. Killam:—Mr. Pickering speaks of the difficulty of locating the bridges on two parallel lines. Certainly those two parallel lines do not bear the same name. Then, if there is any difficulty, it would be for the want of proper information being given. It should not be difficult to locate from the telegraphic report which line the bridge in question is on.

In reference to the mile posts; originally with our road, some thirty years ago, the mileage was numbered on square blocks on telegraph poles, but in taking them down year after year, when it became necessary to repaint the numbers they would sometimes get up in the wrong place and the telegraph company would come along and take their poles down and put in a new one and finally the number board would get lost. We measured the entire road and

put down cedar posts with the blank side from the road, and on one side was given the mileage from Montreal and on the other side the mileage from Halifax. The branches were also furnished with mile posts of a similar kind.

The Chairman:—Does your system of bridge numbering refer to the mile posts?

Mr. Killam:—The mile posts are shown in the bridge books, and they are of considerable service in locating the bridges. We can always tell by referring to our books between what two mile posts any bridge is located.

The President:—The committee, in its summary, states as follows: "We do not believe that the association, as an association, wants to introduce any particular system nor to go on record as advocating that particular system; but we believe that a compilation of the answers received makes a valuable addition to the literature of bridge numbering, and that we, as an association, ought to be content with that." It seems to me from the discussion that has been had so far, we cannot come to any definite conclusion, and it occurs to me that it would be useless to discuss the matter any further. I think that we should adopt the report of the committee as it stands, without making any specific recommendation. I would like to have the opinion of the members.

Mr. Pickering:—I move that we adopt the report as it stands.

The motion was seconded and carried.

J. H. Markley, Pres. 1906-7 | G. W. Andrews, Pres. 1894-5. | Jas. Stannard, Pres. 1896-7. | B. F. Pickering, Pres. 1902-3. | A. S. Markley, Pres. 1899-00.

L. D. Hadwen, 3rd V. Pres. | J. H. Fenwell, 2nd V. Pres. | A. B. Killam, 1st V. Pres. | F. B. Schall, Pres. 1911-12

Subject No. 4.

BUILDINGS AND PLATFORMS FOR SMALL TOWNS.

(Continued from last year.)

REPORT OF COMMITTEE.

Relative to the "Arrangement of Buildings and Platforms for Small Towns as to Convenience and Appearance" reported at the last meeting which was referred back to the committee:

The criticism of the report seems to have been in regard to the track back of the depot, and the elevated platform.

As for the track back of the depot, the thought seemed to have been lost sight of that the report distinctly stated: "For stations where but a small amount of freight is handled, a house track back of the station is not desirable. Where, however, a large amount of freight is received, as is occasionally the case in small towns and on busy roads, and where considerable time would be lost by local freight trains getting out of the way of other trains, a track back of the station is desirable." It was not intended to make this a general standard, but to be used in cases where considerable quantities of freight being received could be unloaded while waiting for other trains to pass. If such conditions do not exist, the committee does not recommend the layout.

Concerning the platforms, general conditions must govern. If heavy freight is received, a high platform of proper size is usually desirable.

At some small stations, large quantities of cotton, broom corn, oil in barrels, ore, etc., are received for local shipment. In such cases an elevated platform would seem a necessity. They should be placed as conditions would seem best for transferring from wagons to cars or vice versa, and far enough from other buildings so as not to endanger them in case of fire.

For the above reasons and with these explanations, the committee does not see its way clear to change its last year's recommendations, and begs to submit the following conclusions:

(1) Passenger stations and combination passenger and freight stations with their platforms should be contiguous to and face the main track.

(2) Where but a small amount of freight is handled, platforms level with the car floor are not generally desirable. Where a considerable quantity of heavy freight is handled, platforms at or nearly the height of the car floor are desirable. Such platforms may be adjoining the station building or at a distance from it contiguous to a team or unloading track as conditions require. When they constitute a part of the depot platform, they should not in general extend nearer the main track than the front line of the station building and in no case nearer than eight feet of the main track rail.

(3) Grain elevators, oil houses, cotton, broom corn or other platforms or buildings storing inflammable or semi-inflammable merchandise should be located, as far as practicable, so as not to endanger railway or other property.

(4) Section tool houses should, where practicable, be located adjacent to the main track and preferably outside of side track limits.

C. H. Fake,
N. H. LaFountain,
H. M. Jack,
B. F. Beckman,
O. H. Andrews,
R. J. Bruce,
Committee.

DISCUSSION.

Mr. Fake:—I would like to state to the convention that I was unable to be at the meeting in Denver last year, and there was some discussion on a portion of this report. I called the attention of the other members of the committee to the report, stating that this particular paragraph was only an exception, and when they understood it in that way it was agreed to by all. I also wrote to the different members of the association who discussed the question, and when they understood the meaning of it, they agreed that it was practically satisfactory. The report of last year upon which there was discussion, under which it was returned to the committee, reads: "For stations where but a small amount of freight is handled," etc., (reading this portion of the report).

That is the paragraph on which the convention had the question resubmitted to the committee, and when it was understood that way it was not taken fully into consideration, I judge from the discussion, but it stated that where but a small amount of freight is handled, a house track back of the station is not desirable. The committee fully agrees that a track back of the station is not desirable except in special cases, but in certain cases it is quite desirable. The convention seemed to think that the report was intended to convey the meaning that there should be a track back of the station in all cases, which was not the intent and meaning if the committee's report at all.

Mr. Penwell:—I was one of the members referred to in this discussion last year, and after having some correspondence with Mr. Fake during the year, and after reading his proposed supplemental report I wrote him to the effect that I was ready to recommend the report with the additional paragraph that he has just read. There is only one exception that I could now take to that, and that, as was mentioned in my letter to Mr. Fake, does not interfere with the adoption of the report. I am therefore ready to move the adoption of the report, but am not entirely clear as to whether or not the extra track makes it necessary to put in an extra switch in

the main track, particularly on double-track roads where a double-end siding would necessarily require a facing-point switch. If this track can be laid without putting in an extra switch in the main track I am ready to move the adoption of the report. I think it is a good one. Mr. Fake may have something in his mind on that point, and I would be glad to hear further from him.

Mr. Fake:—I have only to say that some switches are always necessary on a railroad. The committee realized the importance of having as few switches as possible in main track, particularly on double-track roads where a double-end track back of the station would have one switch facing. At the same time, there might be occasions where a facing-point switch would be desirable even in that case, as I stated in a letter that I read. I know of one instance or two where at least one to two hours' time was saved in train service by putting this track in behind the depot. Now whether that fact would be of sufficient importance to outweigh the objectionable features of such an arrangement I would say should be left to the superintendent of the road or to those who have the responsibility of the management. I fully agree that it is desirable to reduce the number of switches as much as possible, but we must have at least some, and, if necessary to save time, the only thing to do is to put in enough switches to accomplish that object.

Mr. Penwell:—With the understanding that I get from Mr. Fake's further explanation in regard to switches, I move the adoption of the report.

(Motion seconded.)

The President:—Is there any one else who desires to speak on that subject? I think it would be rather hasty to take action without further discussion.

Mr. Penwell:—It was not my idea to bar out any discussion.

The President:—It has been moved and seconded that the report of the committee be accepted, and the committee be discharged. (The motion was unanimously carried.)

Subject No. 6.

BEST AND MOST ECONOMICAL PUMPING ENGINES.

REPORT OF COMMITTEE.

The committee has given this subject a considerable amount of study, and has conducted a number of tests and investigations in order to submit to the association as complete a report as possible written within the short space of time allotted for such work. The committee does not feel that it is in a position, based upon its investigations, to recommend the best and most economical pumping engines for general use, for the reason that a proper and complete report in this connection would mean a recommendation for each and every condition encountered in railway water service and it is well known that such conditions are very numerous.

Instead of making a report strictly in accordance with the subject in hand the committee was of the opinion that the report would be of greater value if it would make a number of tests with different types of pumping units and submit such tests to the members for their consideration. A tabulated report of such tests and investigations is presented herewith, which is short of several types of pumping units that are used by railways for the reason that the committee did not have access to plants which were properly equipped for carrying on the investigation that they desired, and where tests could be made that would be absolutely reliable and thus avoid only approximate conclusions.

The data submitted herewith, in the accompanying table, was gathered from water stations where reliable figures could be obtained as to the amount of fuel consumed and water pumped, resulting from actual weight and measurement of fuels, reading of meters, etc., and it is correct in so far as the locations and conditions of the various stations are concerned. The points selected where the tests were conducted were such as are commonly found in railway service, and the same results may be accomplished at any station where similar conditions exist.

All of these tests have been reduced to cost per water horse power per hour, and in each instance the cost of fuel is given which can be used as a basis for fuel at any other figures.

The committee would recommend this merely as a progress report and would suggest that such tests and investigations be continued.

C. E. Thomas,
J. Dupree,
G. H. Jennings,
R. A. Luker,
J. B. White,
Committee.

Comparison Statement of Tests.

	BOILER		PUMP		Total Head (Feet)	Water or Thermal Horse Power	Gallons Per Minute	FUEL		Cost Per Horse Power Hour
	Type	Horse Power	Type	Size				Kind	Price	
1	Vertical, ...	45	Duplex, ...	10x6x10	104	5.09	194	Mine Run Coal, ...	$2.00	$0.0316
2	Locomotive, ..	60	Duplex, ...	10x6x10	196	10.6	215	Mine Run Coal, ...	2.00	0.0306
3	Vertical, ...	46	....	14x8½x12	139	10.8	309	Mine Run Coal, ...	2.00	0.0354
4	Locomotive, ..	60	" ..	14x20x12x18	220	23	418	Screenings, ...	1.00	0.0097
5	Walled in, ..	150	" ..	14x20x12x18	220	24	438	Screenings, ...	1.00	0.0070
6	Walled in, ...	80	....	14x8½x10	87	3.8	404	Screenings, ...	1.00	0.0210
7	Motor, ...	25	....	8½x10	49	7.6	611	Electric Current, ...	.04	0.0420
8	Walled in, ...	40	.....	12x8x36	93	5.48	117	Screenings, ...	1.00	0.023
9	Vertical, ...	40	.....	12x8x36	51	1 6	125	Mine Run Coal, ...	2.00	0.0640
10	Gasoline, ...	12	Deep Well, ...	7½x30	108	3.4	124	Gasoline, ...	.12	0.0600
11	Vertical, ...	45	Air Compressor, .	12x12x12	230	16	276	Mine Run Coal, ...	2.00	0.0320
12	Gasoline, ...	6	Single, ...	6x16	61	2.05	133	Gasoline, ...	.12	0.0403
	Gas Engine									
13	Oil Fixture, ..	6	Single, ...	8x10	69	2.54	171	Power Distillate, ...	.02¾	0.0094
14	Oil Engine, ...	12	S. A. Triplex, ...	8x8	143	9.1	252	Fuel Oil, ...	.03	0.0026
15	Gasoline, ...	6	Double Acting, ..	8x10	71	2.51	140	Gasoline, ...	.12	0.0486

DISCUSSION.

The President:—The assistant secretary will please read the report. You have all been supplied with copies of the printed report. Is Mr. C. E. Thomas in the hall?

(Report read.)

The President:—Mr. Thomas, will you please take charge of this discussion?

Mr. Thomas:—Mr. President, this report is not as complete as the committee desired to have it for this meeting. For that reason there are quite a few different pumping units that are not included in it. While we have information on some of them, there is not sufficient data to reduce them to cost per horse power hour. The committee would recommend therefore, that the report be continued another year, at which time we contemplate being able to furnish a report showing in detail the estimated cost per horse power for installation of the different types of pumping units, and along with that show the approximate maintenance cost per horse power per year, which, when made up on that basis, would give some very valuable information.

The President:—Gentlemen, you have heard the report and explanation given by the chairman. Is there any discussion? It hardly seems to me, from the explanation given by the committee, that discussion would be of great value as the report is one of progress.

Mr. Thomas:—In this connection, our investigation develops the fact that there are one or two railroads which have been changing internal combustion engines so as to use a distillate oil instead of gasoline. By so doing they are able to show a reduction in the cost of fuel of from 65 to 80 per cent. This distillate can be purchased for about three cents per gallon, whereas gasoline costs eleven to twelve cents. The same relative horse power is obtainable from the distillate as from gasoline.

The President:—Has any one else something to offer on the subject? The information is very valuable, but it is not complete. I would suggest that the committee be continued.

The Secretary:—I think it a good suggestion, because the committee will be able to gather considerable more information that will be of value. We should really take no other stand.

Mr. O'Neill:—I move that the report of the committee be accepted as a progress report and the subject be continued next year

(The motion was seconded and carried.)

Subject No. 8.

CONCRETE TANKS, STANDPIPES AND RESERVOIRS.

REPORT OF COMMITTEE.

Water tanks for railway service are usually constructed of wooden staves, with steel or iron hoops. The average life of a wooden tank may be taken as about 18 or 20 years, depending on kind of lumber used, care used in construction, and in the attention given to it, such as keeping it filled with water, not allowing water to freeze, keeping the outside painted, etc. The hoops also need constant attention, and in many cases have to be changed once or twice during the lifetime of the wood. Hoops are subject to corrosion, and as this fact was not always apparent without taking them off, it sometimes acted more rapidly than was considered possible, with the result that the hoops broke and the tank collapsed.

On account of these difficulties, other materials have been given consideration. Many steel tanks have been built and are the standard of some railroads, such as the Lehigh Valley R. R. Steel tanks require frequent painting, to keep them in good condition. This style of construction is most frequently used for the larger capacity tanks and reservoirs, say 100,000 gallons or over.

When a water station is established for temporary service, or when it is thought that operating requirements may change, a wooden tank is preferable, because it is easily taken down and reërected in a new location. For permanently located water stations, however, engineers have been looking for some more permanent form of construction, one in which the cost of maintenance is reduced to a minimum, and the introduction of reinforced concrete into all branches of industry has naturally turned their attention to its application to railway water tanks.

It is not generally known that the principles of reinforced concrete construction originated in the construction of tanks or water receptacles. A gardener in Paris, named Monier, desiring some flower pots larger than those obtainable in the market, conceived the idea of taking a wire mesh fabric, shaping it into the desired receptacle and plastering it with cement mortar inside and out. His plan proved successful and he then made some water barrels in the same manner. Later he built some larger reservoirs or tanks. The idea grew, was applied to one thing after another, until reinforced concrete has practically revolutionized construction methods.

While this report is intended primarily to give the present status of the use of reinforced concrete for railway water tanks, tanks and reservoirs built for the water supply of cities and for fire protection will be mentioned because the same principles apply. The earliest record of this form of construction in the United States is a standpipe built at Little Falls, N. J., in 1899. In a paper read before the Boston Society of Civil Engineers last June the statement is made that up to the time of writing that paper only 53 such structures had been built in this country and abroad, but the number is rapidly increasing.

There are many arguments to be made in favor of reinforced concrete water tanks.

(*a*) The required materials can easily be obtained in almost any locality.

(*b*) The experience gained with each tank built gradually decreases the construction cost.

(*c*) A concrete tank need not necessarily be kept filled with water in order to preserve it. Wooden and steel tanks rapidly go to pieces by being alternately wet and dry.

(*d*) It is easily kept clean, because no matter what kind of water it holds, nothing is absorbed by the concrete.

(*e*) There are no maintenance charges. Wooden and steel tanks require painting, calking, renewal of hoops, etc.

FOUNDATION.

It goes without saying that the foundation must be carefully planned and made, but that is equally true of wooden and steel tanks, and also of all railway structures. The foundation required will depend entirely upon the location, and must be determined for each individual case. In some instances it is found that concrete footings with comparatively little excavating are sufficient; in others the concrete footings can be put on grillage; and then, again, it is found necessary to drive piles, either of wood or of concrete. The argument has been advanced that uneven settlement will do less harm to the superstructure of a properly designed reinforced concrete tank than to a wooden tank; still that is not an argument for putting in a poor and insufficient foundation.

SUPERSTRUCTURE.

The design of the superstructure varies considerably, and to some extent is governed by the use to which the tank is to be put.

In a general way there are three designs—

(*a*) A cylinder or prism resting on concrete footings and used for its entire height as a water reservoir.

(*b*) A cylinder or prism resting on concrete footings, having a diaphragm or partition a considerable distance above the footings, that forms the bottom of the water reservoir.

(*c*) A tank of concrete resting on reinforced concrete posts, similar to a wooden or steel tank on a timber or steel husk frame or tower.

Design (a) is used where the volume or quantity of water is the main consideration or where the tank is located on an elevation.

Design (b) is used where the elevation is needed to obtain sufficient pressure, for hydrants or water columns, and where the hydrostatic pressure, if brought to the base of the tower, would be likely to cause seepage through the concrete. The lower portion of the tower can be provided with suitable openings and can be utilized for pumping machinery and for the storage of tools and materials. In case of trouble during severe winter weather, the pipes in a tank of this design can be thawed out without risk. You have all heard of tanks burning down because of trying to thaw out pipes on a cold, windy, winter's day.

The reason for design (c) is about the same as for design (b) without the frost-proofing feature. The various designs are illustrated in specific cases described later on.

ROOFS.

The roofing of concrete tanks and reservoirs is largely a matter of choice. Tanks and reservoirs for water supply located on an elevation, or where there is little soot and cinders, and little likelihood of dust or foreign matter being blown or thrown into them, can be left open, and they frequently are. In fact some railroads are building their wooden tanks without roofs.

A railroad tank should be provided with a roof, which may be of concrete, wood, tile, slate or prepared roofing, as may be desired. A concrete roof would be more in keeping with the structure and have the additional merit of permanency.

APPEARANCE.

The railroads of the country are giving more and more attention to the appearance of their buildings and grounds, especially at the larger and more important stations. Reinforced concrete lends itself very readily to artistic design, and this will be no small argument in favor of the concrete tank. Most concrete tanks so far built are straight cylindrical shafts without much attempt at ornamentation, yet even this presents at all times a better appearance than a wooden tank in need of paint. In Europe more attention has been given to ornamental design than in this country, and the addition of cut stone facing and trimming has added a great deal to the appearance.

There are many reasons why railroads have not taken up the construction of reinforced concrete tanks more generally. In the first place, up to the present time, because of the comparatively few structures of this kind that have been built, the work would be largely experimental, and most of us are inclined to let the other fellow spend his time and money on experiments.

Railroads that have severe cold weather to contend with would not care to try it until assured that the tanks would stand freezing weather without injury. The permanent location of many tanks on account of constantly changing operating conditions and requirements must necessarily be more or less uncertain.

Lack of experience in this form of construction will make the labor charge run high. Every reinforced concrete tank, standpipe or reservior built adds to the sum of knowledge and experience, and one is able to figure more confidently on satisfactory results.

In designing a concrete water tank the item that receives first consideration is the water pressure, because this determines the thickness of wall and amount of reinforcement needed, and makes precaution for waterproofing necessary. In a cylindrical reservoir the water pressure at the base, per square foot, is equal to the weight of one cubic foot of water multiplied by the depth in feet. Take for example a tank 30 ft. high. A cubic foot of water weighs 62.5 lbs. The water pressure per square foot at the base of the tank is $30 \times 62.5 = 1{,}875.0$ lbs.

The tension in the wall for each foot in height is obtained by multiplying the water pressure per square foot by the radius in feet. Take for example the above tank, which we will say is 20 ft. in diameter. The tension in the wall for the first foot in height is $1{,}875 \times 10 = 18{,}750$ lbs. Or it can also be arrived at as follows: $30 \times 62.5 \times 10 = 18{,}750$ lbs.

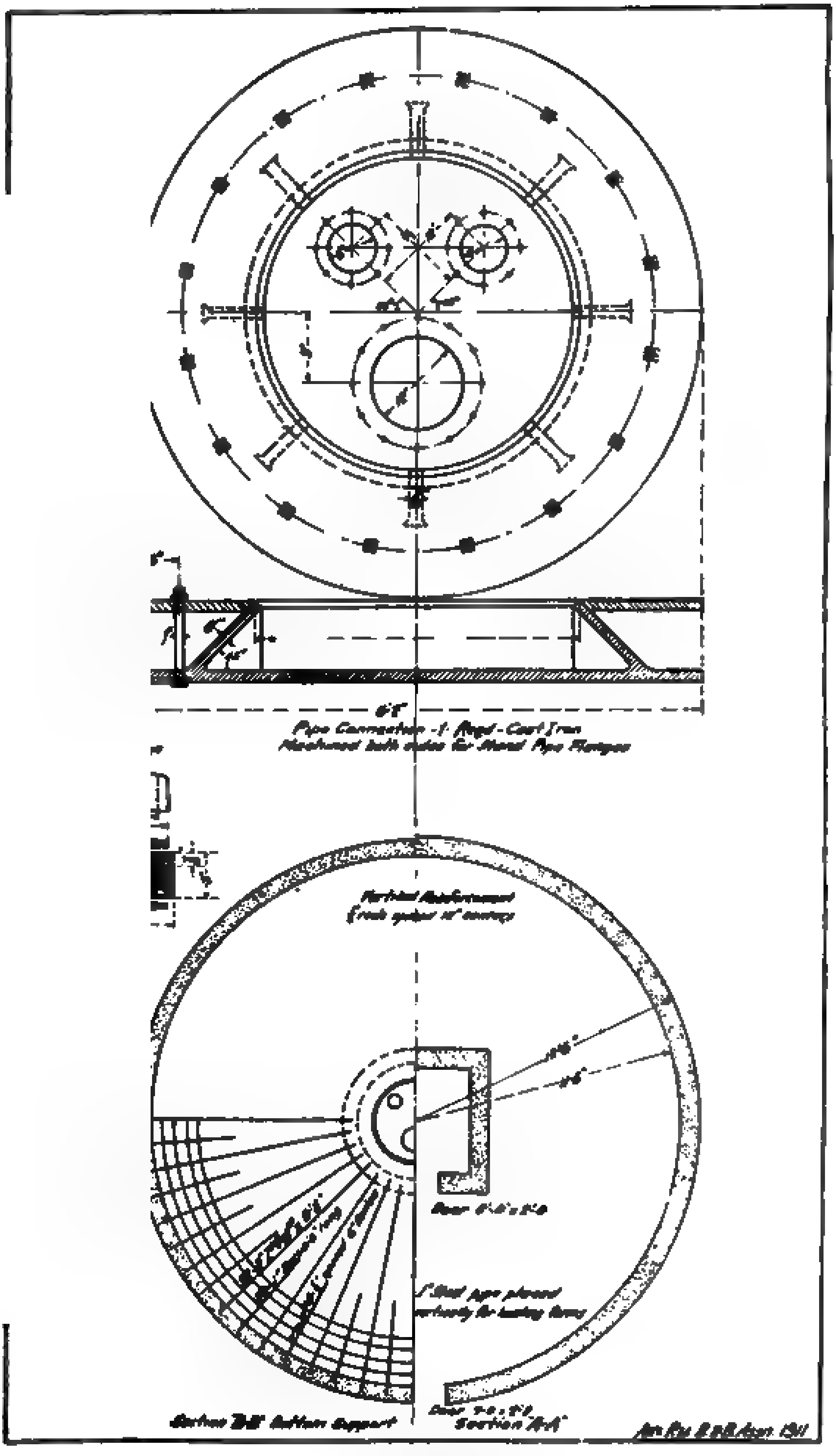
If the same tank were to be made 40 ft. high, the tension would be $40 \times 62.5 \times 10 = 25{,}000$ lbs., and if 50 ft. high, $50 \times 62.5 \times 10 = 31{,}250$ lbs.

It will thus be seen that increased depth of water materially increases the tension in the wall, and increased diameter also adds in proportion. Therefore, the larger the reservior, both as to diameter and height, the greater the need of an impermeable concrete.

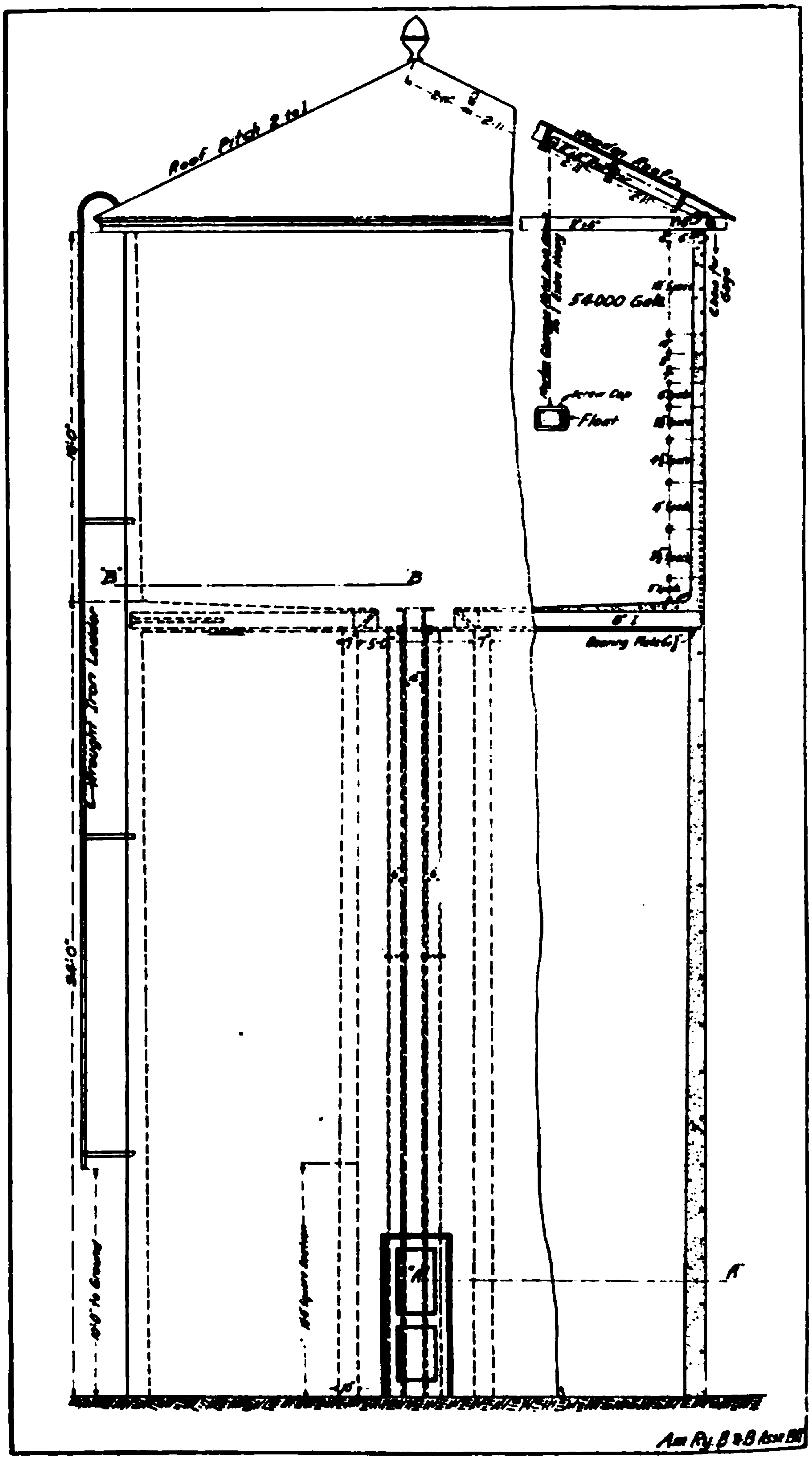
The Journal of the Association of Engineering Societies for June, 1911, has a paper by H. B. Andrews entitled "A New Theory for the Design of Reinforced Concrete Reservoirs," and a discussion by various engineers experienced in this line of work, that will be of value and interest to any one desiring to design and construct a reinforced concrete tank. This paper and also an editorial on it appear in the Engineering News of July 27, 1911. In the Proceedings of the American Railway Engineering Association, Vol. 12, part 3, 1911, will be found "Suggested Specifications for a Reinforced Concrete Water Tank" that are also of value.

Various means are used to insure a waterproof concrete, but it is usually aimed to accomplish this if possible by using a rich mixture, rather than by adding waterproofing compounds to the concrete or applying them to the surface. Hydrated lime or special preparations are sometimes added to the concrete for the purpose of making it denser and thus more impermeable to water. The walls and floor are sometimes coated with a 1:1 cement mortar

Concrete Tank, Austinburg, O.—Pennsylvania Lines



Concrete Tank, Austinburg, O.—Pennsylvania Lines.



Concrete Tank, Austinburg, O.—Pennsylvania Lines.

or some waterproofing preparation of which there are a number on the market.

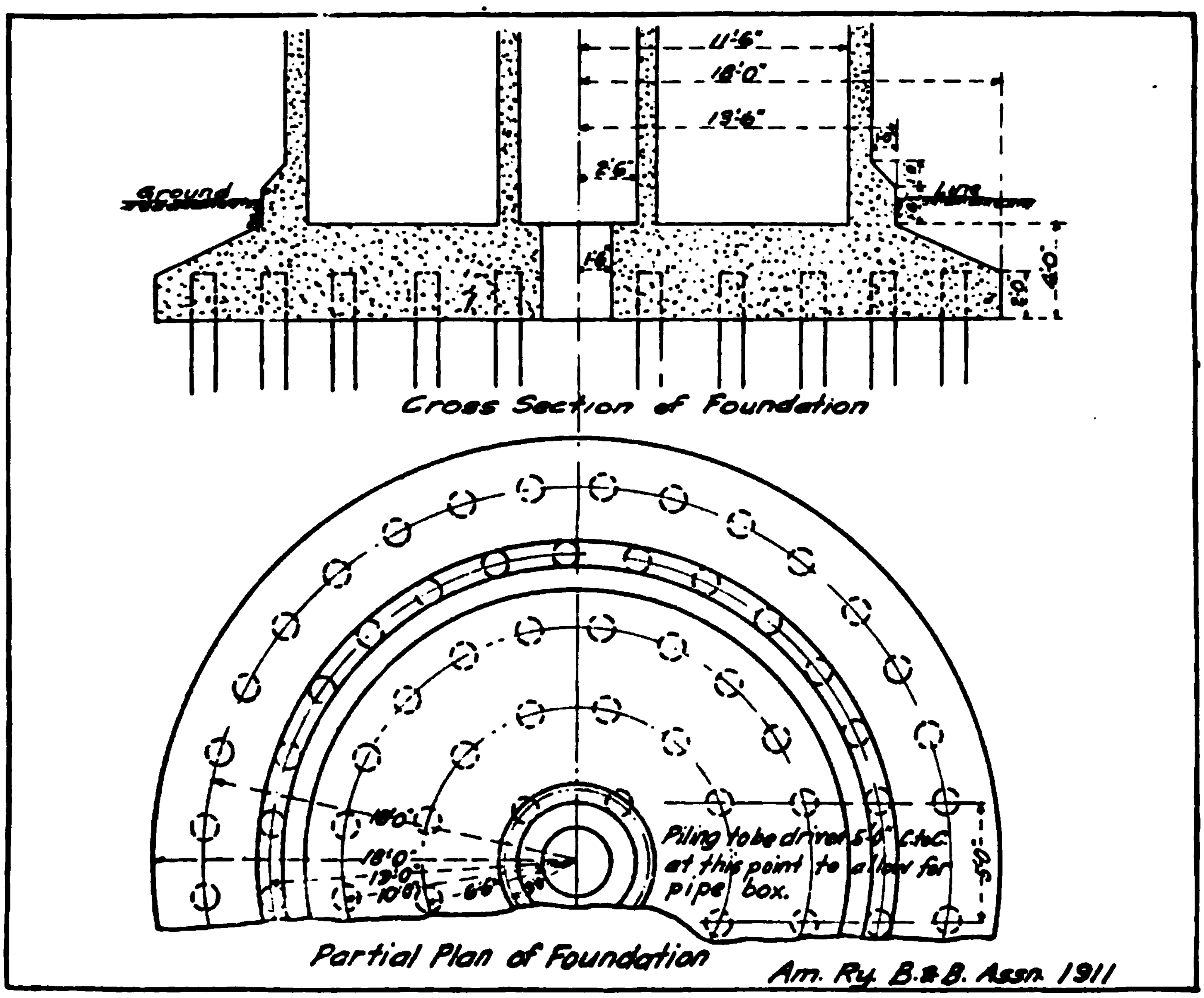
It is interesting to note that the standpipe on the state farm at Bridgewater, Mass., was built by inexperienced prison labor. The standpipe is 30 ft. in diameter, 78 ft. high, with walls 20 in. thick at the base and 12 in. at the top. The concrete consisted of cement, sand and gravel in proportions to 1 : 1½ : 3½ and was found to be absolutely water tight.

The steel reinforcement in the base should be carried up into the walls, because when the tank is filled with water the pressure tends to increase the diameter of the walls and might cause cracks at the juncture of the walls and base that would allow seepage. The sections of the horizontal reinforcing rods in the walls should be properly joined to make a complete circle.

At Attleboro, Mass., a standpipe 50 ft. in diameter was built and the following method was followed: Bars were obtained long enough so that three would reach entirely around the circumference with a lap of 40 diameters at each joint. Two wire rope clips were then used at each splice. These clips were tested at the Watertown arsenal and found sufficient to secure the full working stress of the bare bars.

The Pennsylvania Lines built a 54,000-gallon concrete water tank at Austinburg, Ohio, at a cost of $3,500. This tank is 24 ft. in diameter, 16 ft. deep, and is raised 32 ft. above the track level. The walls are 8 in. thick at the bottom and taper to 6 in. at the top. The drawings attached to this report show the details of construction.

A rich mixture of concrete was used with a set of watertight steel forms, and no other precaution was taken to make the work waterproof. It is felt by those having the work in hand that the success of this tank is due to the use of tight steel forms which retain in the concrete the fine particles of cement that might escape where wooden forms are used. Mr.



Foundation for Concrete Tank for Pennsylvania Lines

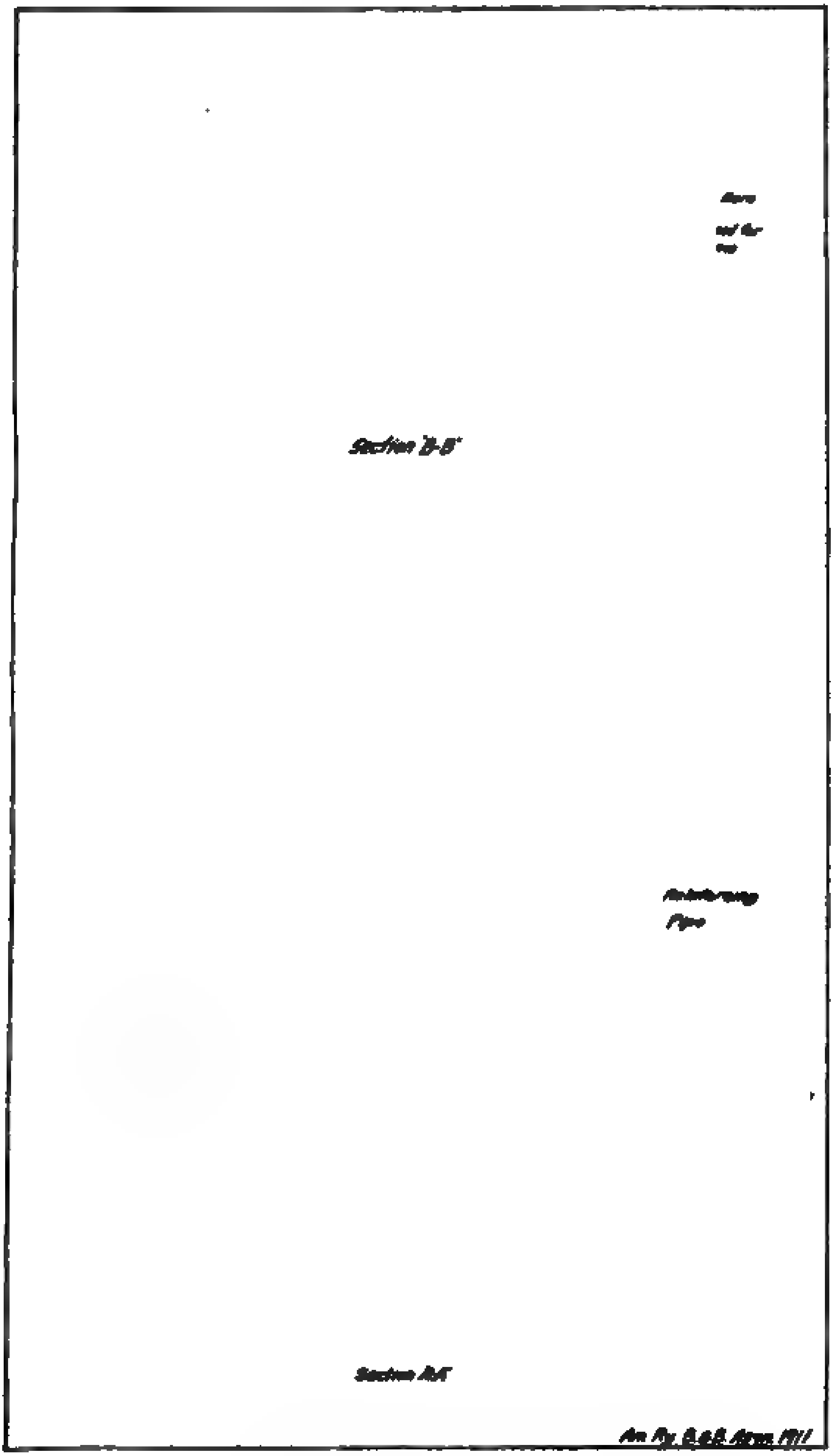
Concrete Tank, Austinburg, Ohio.—Pennsylvania Lines.

W. R. Hillary, division engineer, in charge of the work, states that from the experience gained he would not hesitate to construct another tank along the same lines; also that a tank of twice the storage capacity could be secured with very little increase in cost.

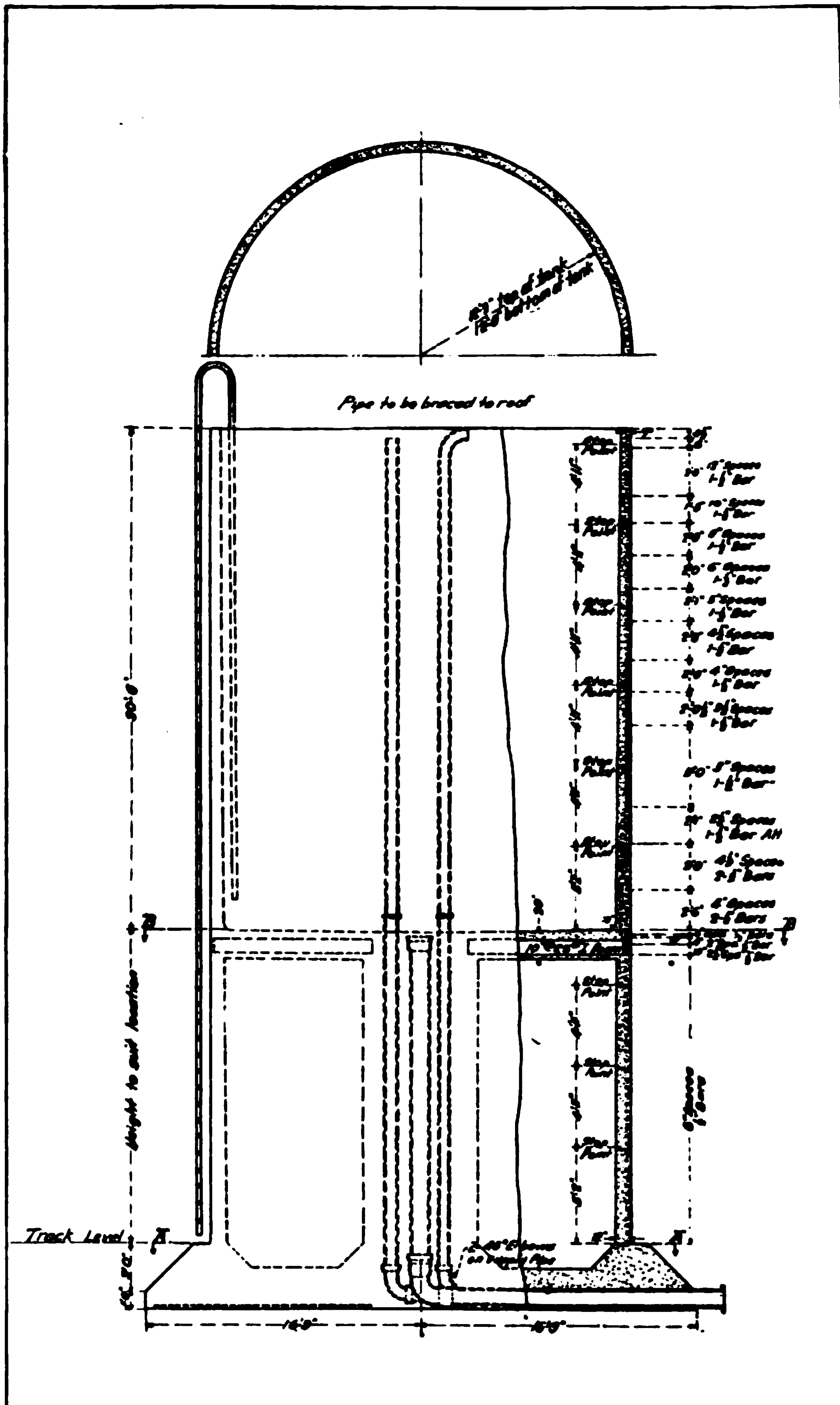
It was necessary to drive piling for this tank because a layer of quicksand was encountered in excavating. A wooden roof was placed on this tank, but Mr. Hillary states that if he were to build another he would use a reinforced concrete roof. The tank has given perfect satisfaction and has passed severe winter tests without showing any ill effects. The tank at Austinburg was built by the Steel Concrete Construction Company, of Harrisville, Pa.

The Southern Railway Company has built two concrete tanks, one at Ooltewah and the other at Bulls Gap. Drawings showing the latter are included in this report. These tanks were built of 1:2:4 concrete except in the tank proper, where the mixture was made richer, namely: 1:1½:2½, in order to insure water-tightness. No waterproofing compound was used. Both of these tanks showed a little seepage when they were first put in service, but this disappeared entirely after a month's service.

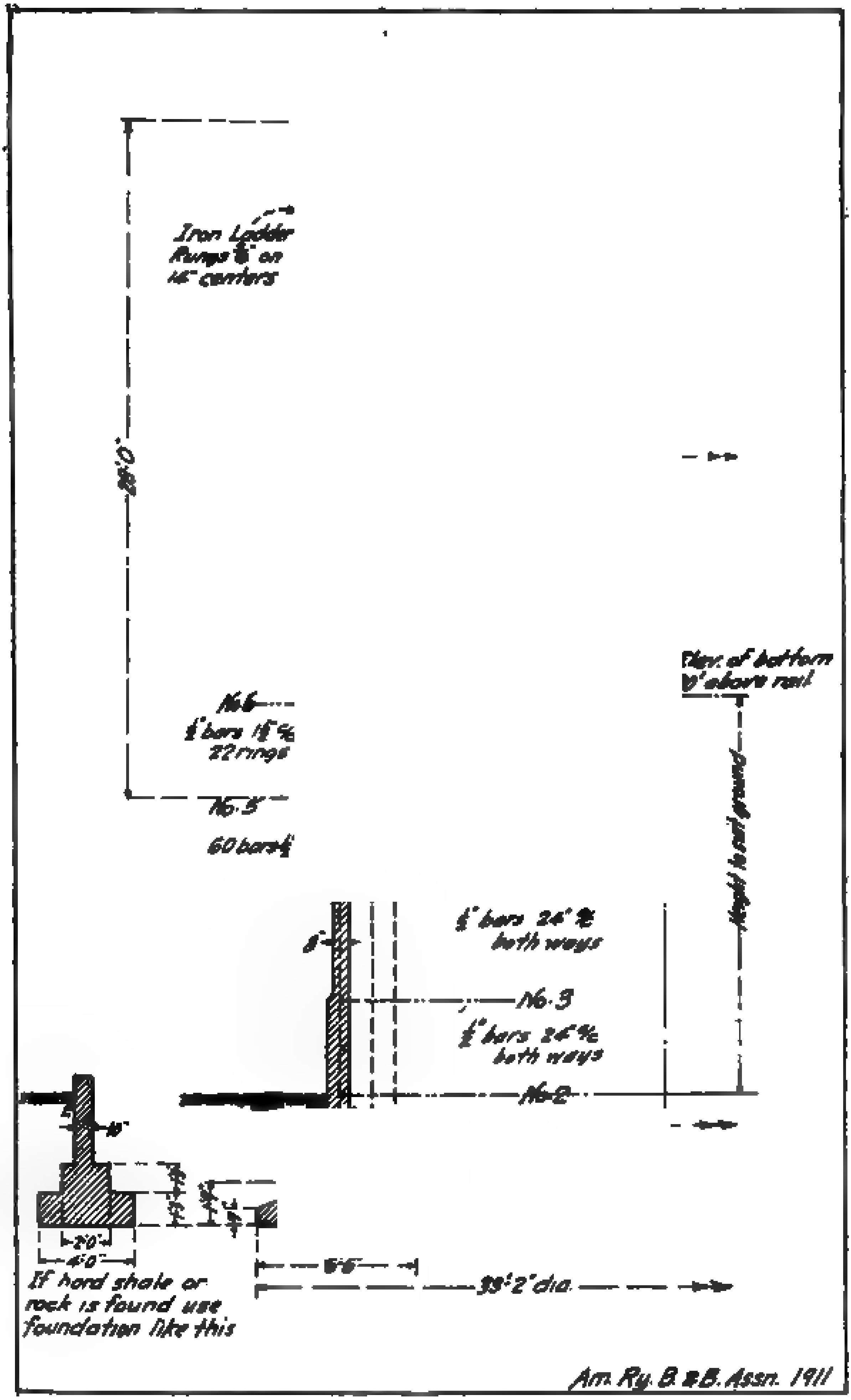
In 1909 the Southern Pacific Company, on one of its lines in Mexico, the Cananea, Yaqui River & Pacific Ry., built a reinforced concrete tank at Empalme, Sonora. A drawing showing the method of construction is attached.



Concrete Tank, 100,000 Gallons Capacity, Designed for B. & O. R. R., by the Steel Concrete Construction Co.



100,000 Gallon Concrete Tank Designed for B. & O. R., by the Steel Concrete Construction Co.

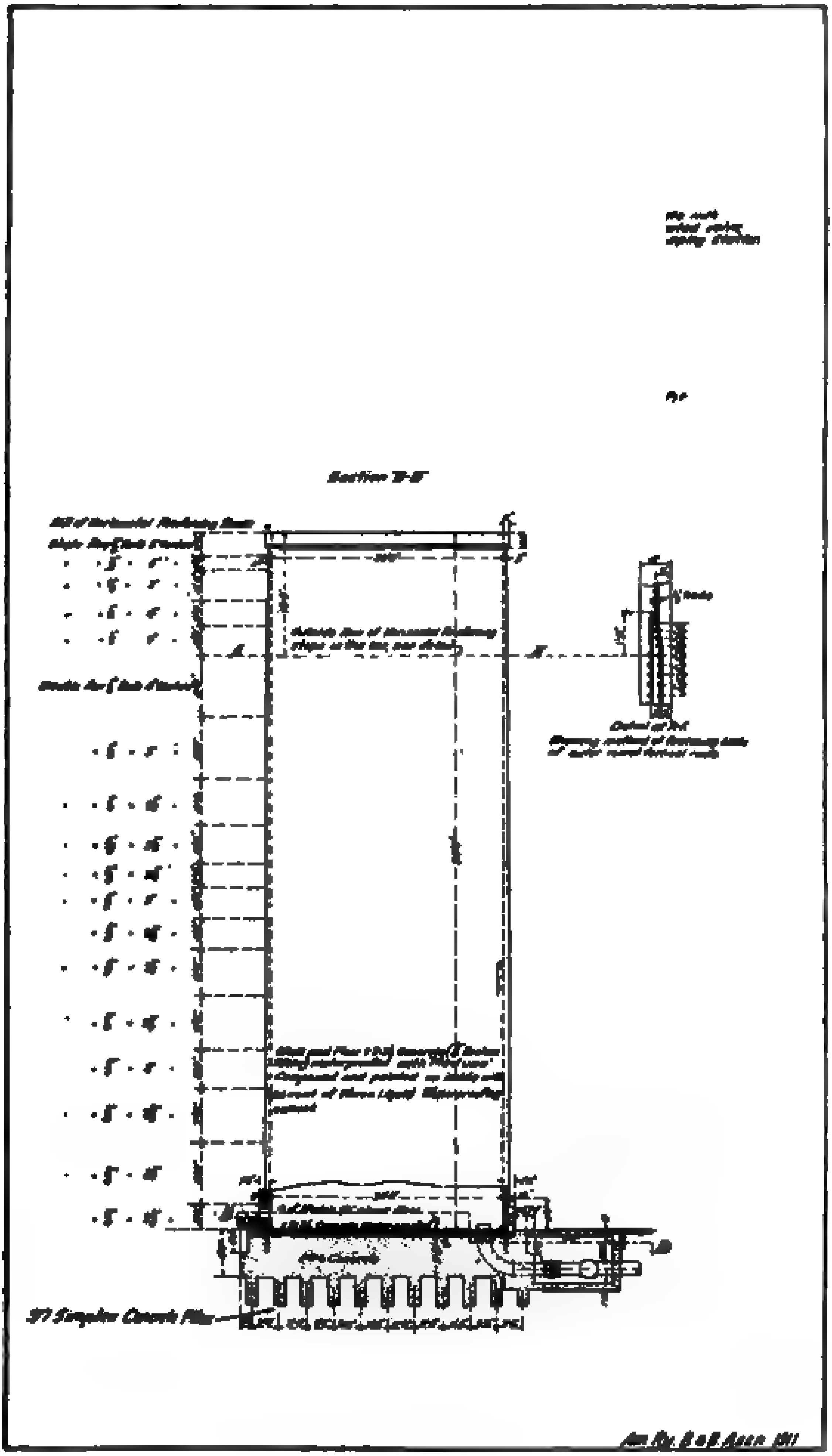


Concrete Tank at Bull's Gap, Tenn., Southern Ry.

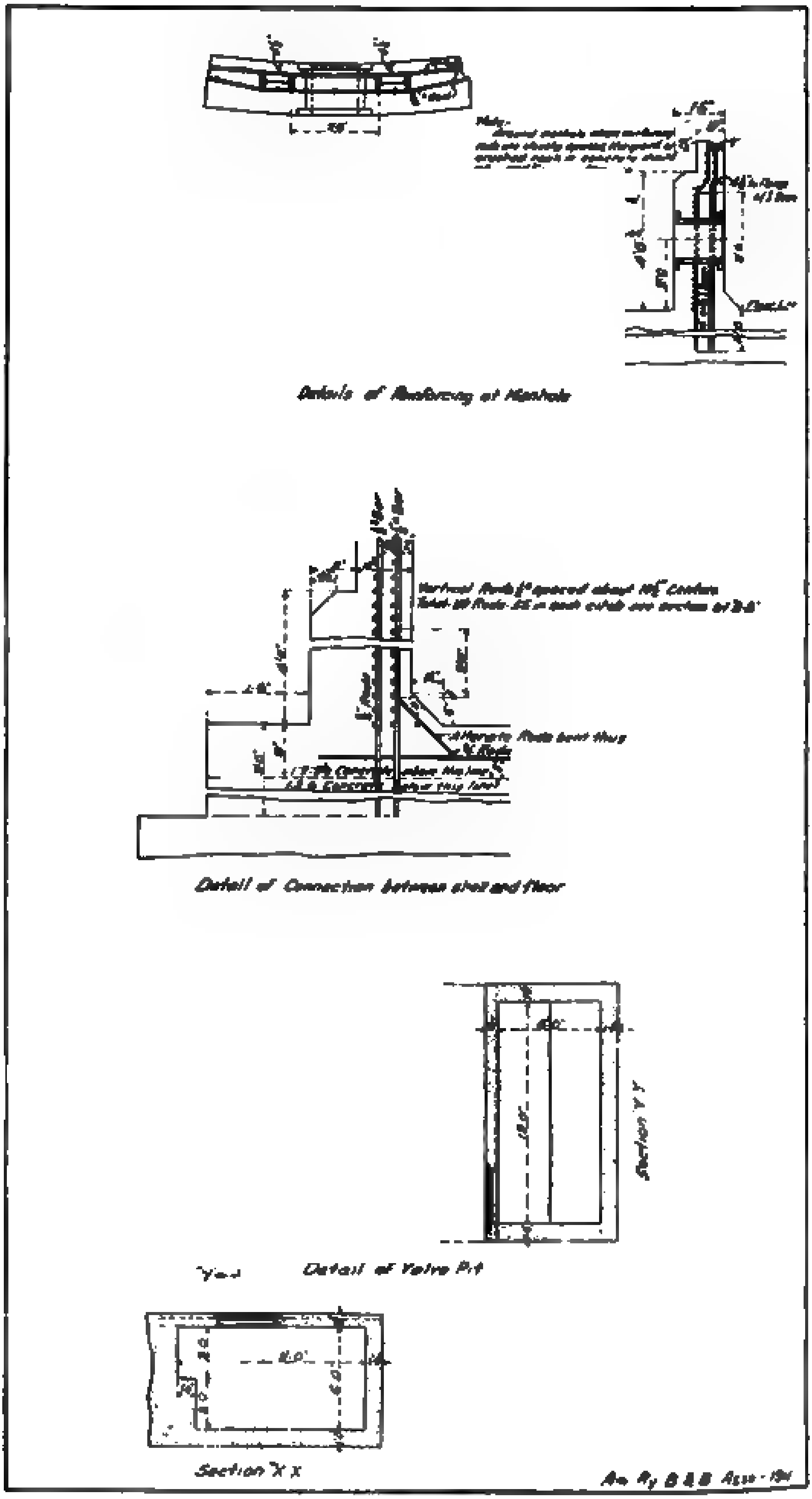
Concrete Tank at Ooltewah, Tenn., Southern Ry.

The foundation is octagonal in shape and rests on 97 Simplex concrete piles. Where the walls and floor join, the walls are 18 in. thick for a distance of 4 ft., and above that they are 10 in. thick at the bottom and taper to 5 in. at the top. The walls and floor are formed of 1:2:3½ concrete, with ¾ in. broken stone, and the foundation is of 1:3:6 concrete. The walls and floor are waterproofed with Medusa compound and the inside painted with one coat of Werco liquid waterproofing cement. When the tank was first filled it showed signs of sweating, but after a few weeks this passed away and the outside has been perfectly dry ever since.

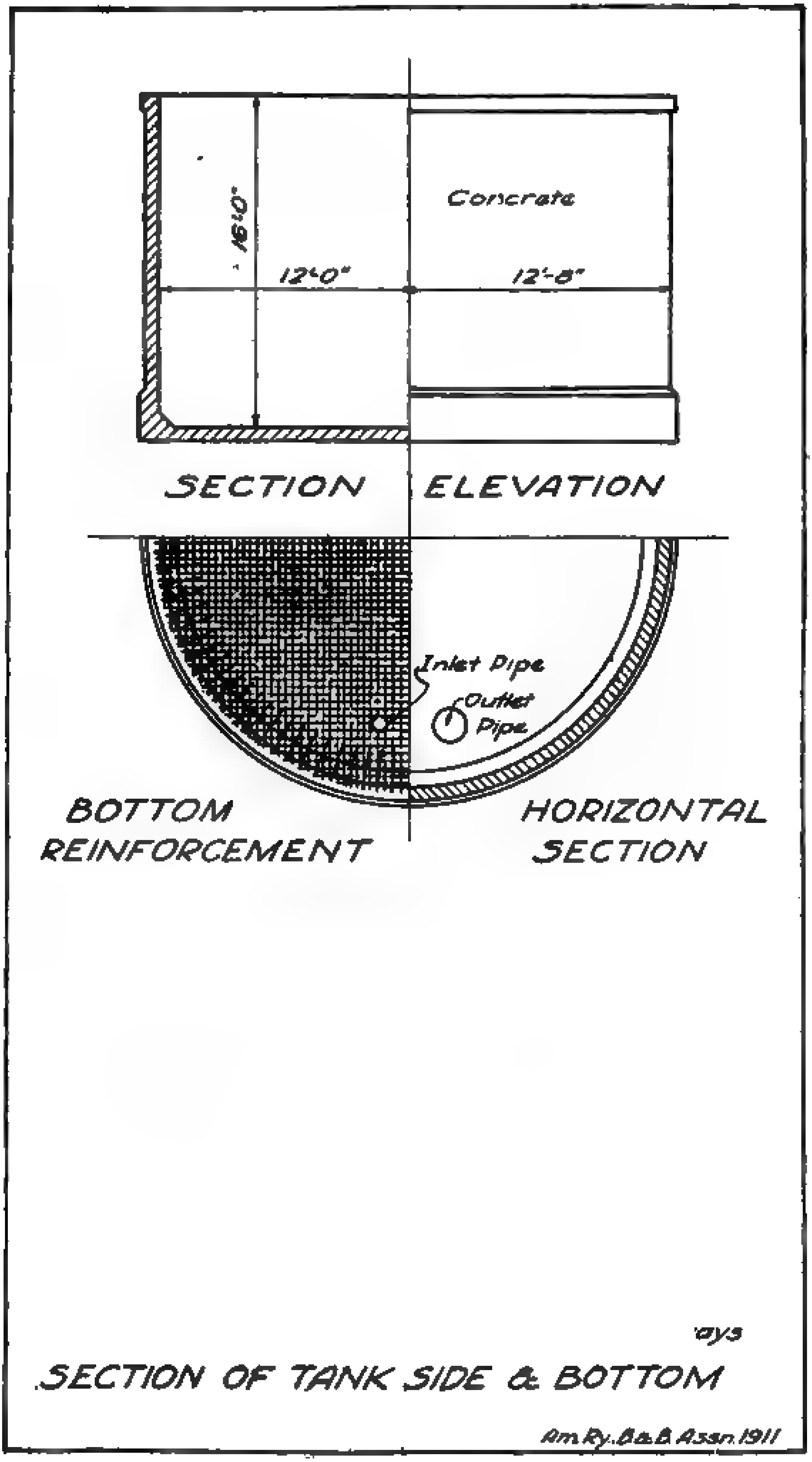
During the year 1909 the Spokane, Portland & Seattle Ry. constructed a reinforced concrete water tank 24 ft. in diameter, 16 ft. high, with a capacity of 48,000 gallons. The walls and floor are 8 in. thick, but where they join the walls are 12 in. thick for a distance of 2 ft. The joint between walls and floor on the inside of the tank is beveled, and bent reinforcing bars are carried from the floor to the walls. The concrete was of Portland



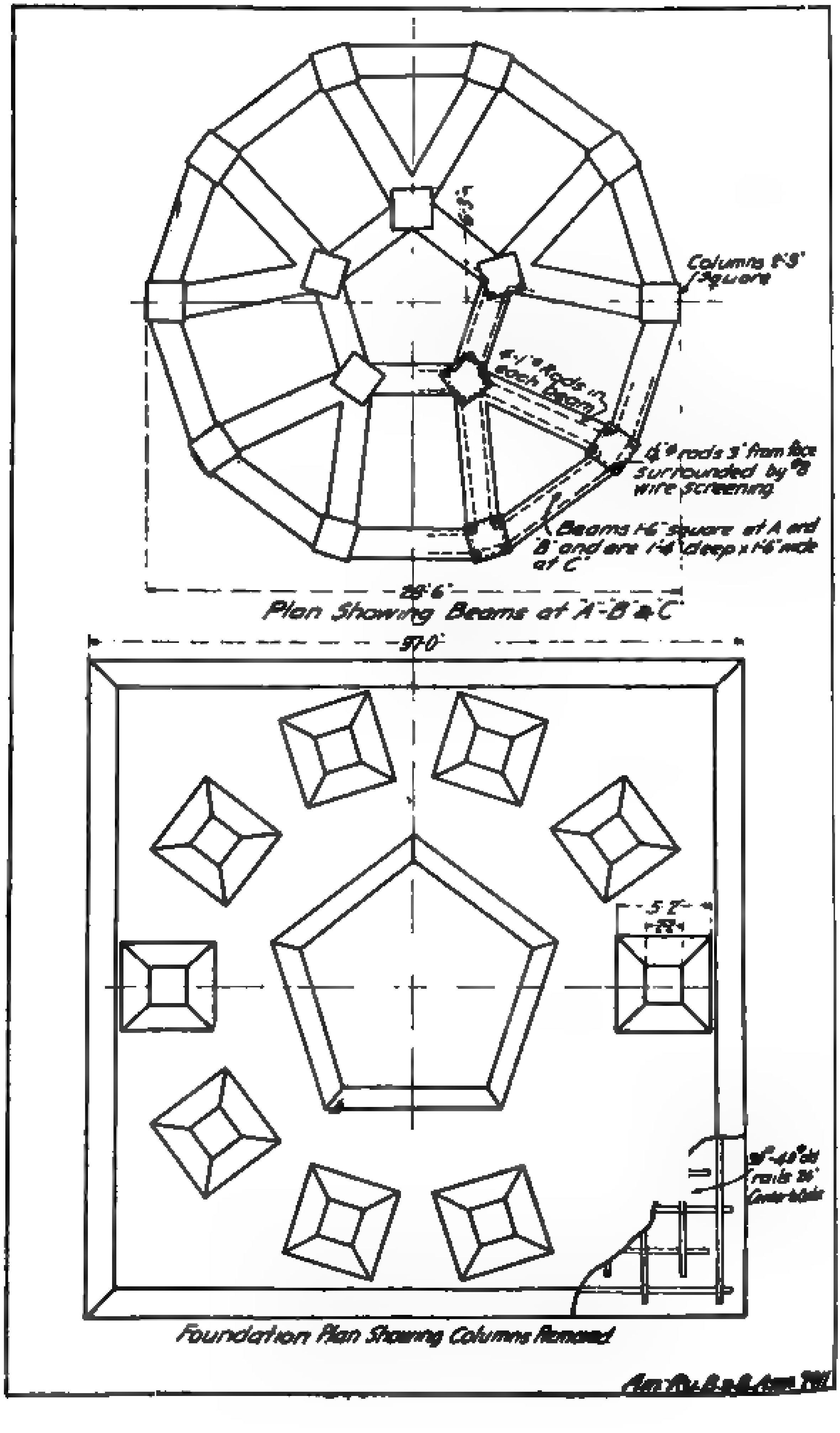
Concrete Tank at Empalme, Mexico,—Southern Pacific Co.



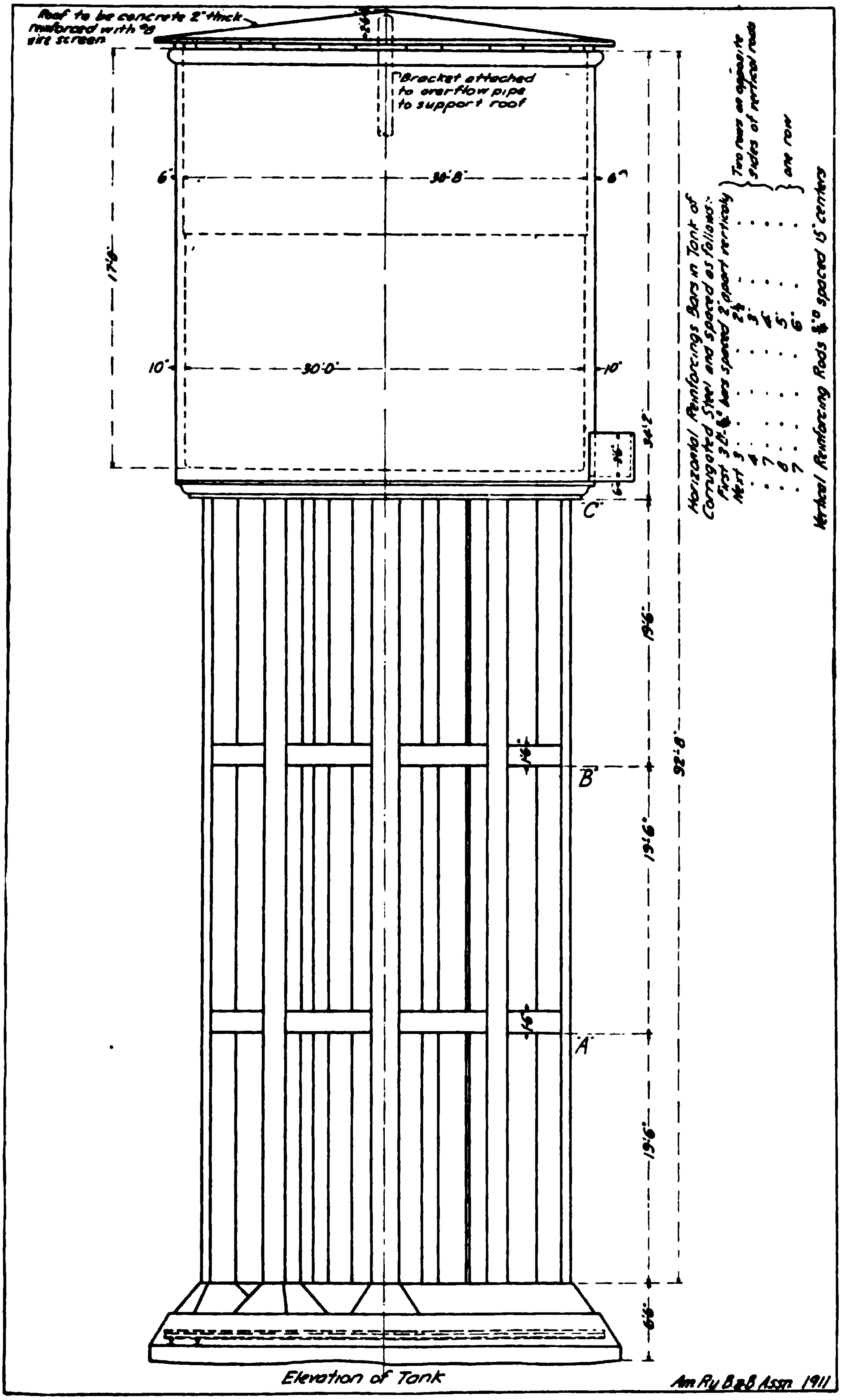
Concrete Tank at Empalme, Mexico.—Southern Pacific Co.



Concrete Tank, Spokane, Portland & Seattle Ry.



Foundation Details, Concrete Tank, Anaheim, Cal.



Concrete Tank and Tower, Anaheim, Cal.

cement, sand and stone in the proportions of 1:2:4, the stone being ¾ in. in size. The specifications required that the broken stone must be pushed back so as to leave 1 in. of mortar next to all surfaces, both inside and outside. Care was taken to compact the concrete so as to make it as nearly waterproof as possible. The illustration shows how the reinforcement was carried from the floor into the walls.

During the year 1907 a reinforced water tank on a reinforced concrete tower was built for the Municipal Electric Light Plant and Water Works, of the City of Anaheim, California, at a cost of $11,400, having a capacity of 172,000 gallons. This tank presents a very pleasing appearance, as will be noted from the illustration; and a description is covered in the following extracts from the specifications:

"Type:—A reinforced, monolithic concrete tank and tower, as shown in the accompanying drawings, which are hereby made a part of these specifications. The structure should be designed to give as attractive an appearance as possible. All corners of columns and beams are to be beveled or rounded. Forms must be of surfaced lumber where in contact with concrete, and must be true, to give as even a surface as possible.

"Capacity:—Tank is to be 30 ft. 0 in. inside diameter for 17 ft. in height and 30 ft 8 in. inside diameter for the remainder of the 32 ft. of height. The tank floor is to be 10 in. thick, with additional thickness of 16 in. in the beams. Columns each 2 ft. 3 in. square are to be arranged as shown, and connected with beams 18 in. square.

"Construction:—The excavation for the foundation is to be carried down full six feet below the ground level. If any quicksand or other treacherous soil is found at the bottom of the excavation this is to be removed to a depth of 18 in. and replaced with clay or loam. Before depositing the first concrete the ground must be thoroughly wet and then tamped. The concrete for the foundation is to consist of: One part Portland cement, three parts clean, sharp sand, four and one-half parts broken rock, or screened gravel consisting of particles varying in size from ¼ in. to 3 in. greatest dimension.

"The concrete for the columns and beams supporting the tank is to be: One part Portland cement, two and a half parts clean, sharp sand, and three and a half parts broken rock consisting of particles varying in size from ¼ in. to 2 in. greatest dimension.

"The concrete for the tank is to consist of: One part Portland cement, two parts clean, sharp sand, and two and one-half parts broken rock varying in size from ¼ in. to 1 in. greatest dimension.

"The cement is to be of some brand approved by the engineer and have a tensile strength of at least 180 lbs. per square inch when made into neat cement tests briquettes, after hardening one day in air; and a strength of 450 lbs. per square inch after 7 days. Not more than 4 per cent must remain on a 100-mesh screen, and 18 per cent on a 200-mesh screen.

"In all portions of the work care must be used to proportion the different size particles of sand and rock to prevent voids, and special care must be observed in this regard in placing material for the tank.

"The arrangement and support of the forms and reinforcing material must be such that there is no shifting of either after the concrete is in place.

"The concrete must be thoroughly and properly mixed (either by hand or machine) and wet with just enough water to show on the surface of the concrete after it is thoroughly tamped.

"The work must proceed as continuously as possible. Not more than one yard of concrete may be mixed and wet before putting into the forms, and it must not be allowed to stand more than twenty minutes before placing. Whenever the placing of concrete is stopped for more than four hours the old work must be washed clean and a thin layer of grout placed upon it before adding more concrete.

"There must be at least one tamper for every shoveler and no large quantity of concrete must be placed without thoroughly tamping.

"Reinforcing:—Reinforcing steel must be placed as uniformly as possible. All bars in tension must be lapped 12 in. and fastened together with two

Concrete Tank and Tower, Anaheim, Cal. Capacity, 172,000 Gallons.

cable clamps or other approved methods. Rods in compression must have their ends kept in line by being placed in a piece of closely-fitting pipe 12 in. long.

"General:—The forms must not be removed before 10 days after the concrete is placed, and the concrete must then be thoroughly wet once every 24 hours for 10 days.

"The tank must be provided with three outlets, as shown, a supply pipe 12 in. diameter, over-flow pipe 12 in. diameter, clean out pipe 6 in. diameter. The concrete around the supply pipe must be built up 2 in. to prevent sediment from getting into the distributing system, and the floor of the tank must slope one inch from all directions toward the clean out pipe. The inside of the tank is to receive a water proofing coat ½ in. thick, of one part cement and one part fine sand. The wall of the tank must be roughed up to receive this coat, and it be thoroughly rubbed down.

"The tank is to have a reinforced concrete cover, as shown, supported at the center by a projection from the top of the over-flow pipe. Ten spaces each 6 in. high by 30 in. long are to be left open, as shown, and covered by one layer each of 4-mesh galvanized screen of No. 10 wire and one of 12-mesh galvanized screen of No. 28 wire. Ladders must be provided to give access to the platform at the base of the tank. A hole in the cover 24 in. square must be provided with tight sliding cover, and a ladder from the platform at the base of the tank lead to this hole, to admit inspection of the interior of the tank.

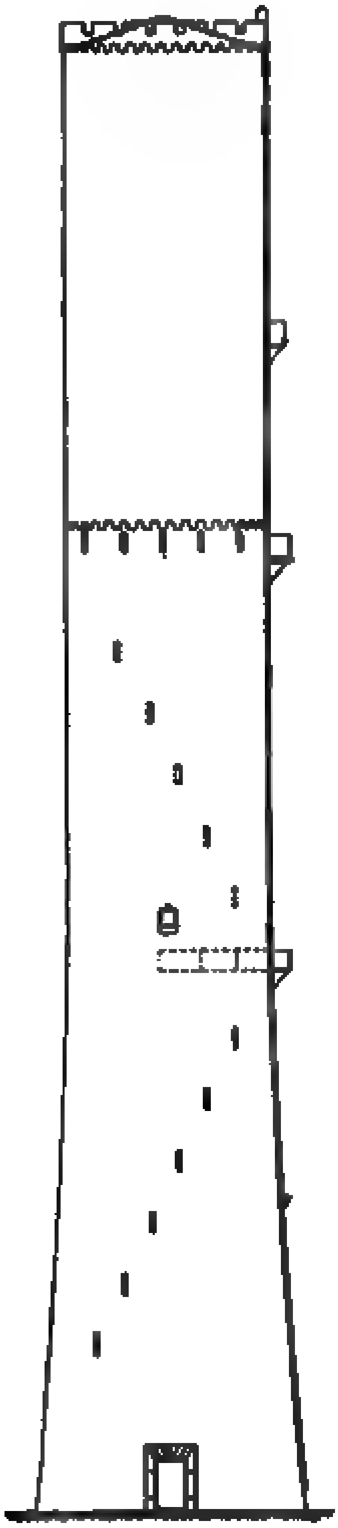
"The tank will not be accepted until it has been filled with water by the contractor and allowed to stand ten days. If by that time no cracks appear in the structure, or unequal settlement or a total settlement of more than one inch occurs, and there is no leaking of the tank more than a slight sweating and no other defects or failures are evident, the structure will be accepted by the City of Anaheim. If any defect is disclosed by this test the contractor shall have thirty days to remedy the same. If he does this so that it will stand the above test it may then be accepted by the City of Anaheim; if not he must refund the entire cost to the City."

Early this year a reinforced concrete standpipe was completed for the U. S. Naval Station at Key West, Fla., 80 ft. in diameter, 40 ft. high, with a capacity of 1,500,000 gallons, costing $19,950. It is impossible to get good water from wells in this locality, and the standpipe was built to conserve the supply of rain water falling from August to December each year. The method of reinforcement is of interest and I take the liberty of quoting from Engineering News:

"The standpipe consists of an 18-in. wire-mesh reinforced concrete foundation, with an extra depth under the side walls, and a 6-inch wire-mesh reinforced concrete bottom, integral in construction with the circular side walls. The reinforcement of these walls consists of vertical 4-inch 5.25-lb. channels, spaced 6 ft. 4⅜ ins. c. to c., for the bottom 25 ft., and 2x2x5/16-in. angles, with the same spacing for the top 15 ft., bonded together with circumferential round rods of variable size and spacing, as shown on the drawing. These circumferential rods are tied together by special clips, spaced so as to break joints, and were held to the uprights by 1/16-in. wires passed through holes punched for the purpose, in the channels and angles.

"The base concrete was 1:3:6, and all other 1:2:4 mixture. The specifications provided for bonding of the successive sections of cistern wall, which were made about 3 ft. in height, by beveled joints and by ½-in. upset end steel dowel pins 12 in. long and spaced 12 in. apart. After completion the work was smoothed down and the outside given a brush coat of cement grout. The interior, including the floor, was required to be plastered with three coats of cement mortar, after which four coats each of soap and alum washes were to be applied. Some efflorescence has appeared on the outside of the standpipe, but no leakage is as yet evident, though on account of drought a full depth test has not yet been available."

A reinforced concrete tank was recently built by the Central of Georgia Ry., at Savanna, Ga., which has several unique features and is described as follows by Mr. H. E. Sharpley, assistant to the chief engineer:



Concrete Tank, Central of Georgia Ry., Savannah, Ga.
(Cut furnished by Eng. News.)

A 150,000-gallon reinforced concrete tank was recently built at Savannah, Ga., which it is believed is the highest tank of its character in the world, the same being 187 ft. 3 in. from the ground line to the top of the parapet wall and 187 ft. 9 in. to the peak of the roof. It consists of a tapering hollow chimney-like shaft, 33 ft. 7 in. inside diameter at the ground line, tapering to an inside diameter of 24 ft. 7½ in. at a height of 66 ft. from the ground line, at which point the shaft assumes a cylindrical form and continues thus to the top.

The tanks were formed by putting in two partitions in the shaft, these partitions serving as the bottoms of the tanks, and being of reinforced concrete and dome shaped. The receptacles above the dome-shaped partitions or tank bottoms form the tanks.—The upper one having a capacity of 100,000 gallons and the lower one 50,000 gallons. The upper tank is used for the storage of water in case of fire on the terminals, and the lower tank for general use.

The structure is carried on a foundation consisting of 112 piles, with three additional piles supporting the riser and over-flow pipes; all having a penetration of 30 ft. below permanent moisture and driven 3 ft. centers in three concentric circles.

The concrete in the foundation consists of a 1:2½:5 mixture, and was poured around the piles on a mud foundation, without the use of grillage.

The reinforcement for the foundation consists of ¾ in. corrugated bars laid both radially and as concentric circles. Six of these circular reinforcing rods, together with two ½ in. metal rods 2 ft. long spaced 10 ft. apart, tie in the foundation around the piling, preventing any tendency of the foundation to spread outward. Three circles of ¾ in. reinforcing rods on top of the piling act to distribute the pressure from the radial reinforcing rods, which consist of 294 ¾ in. bars 10 ft. long laid in a horizontal position on the top of the circular reinforcement, and they are spaced 6 in. apart at the periphery. Six additional concentric circles of ¾ in. rods are laid on top of these radical reinforcing rods to still further tie in the foundation.

The foundation is 10 ft. 6 in. wide for a height of 3 ft. 9 in., from which height it tapers in a height of 22 in. to 9 in. in width at the base of the hollow shaft.

The walls of the shaft below the tank were made of a 1:2:4 mixture, and reinforced horizontally with ½ in. bars embedded near the middle of the wall, properly curved and laid in a spiral. The pitch of the spiral is one foot vertical for each complete circumference, resulting in what is practically a ring or hoop of ½ in. bars every 12 in. in height of tower. The reinforcing rods were lapped over 24 in. and wired. The vertical reinforcement was also ½ in. bars spaced 24 in. centers, lapped 24 in. and wired to the horizontal reinforcement.

At the periphery of the tank bottoms the walls of the shaft were widened to form a supporting ledge for the dome-shaped bottoms, as well as to permit of the necessary reinforcement to resist the tendency of the dome-shaped bottom to flatten out from hydrostatic pressure. This hydrostatic pressure was taken care of by using horizontal rings of ½ in. bars, each ring being made up of a sufficient number of ½ in. bars, lapped 42 in. at the joints or splices, in successive rings staggered, and the successive rings so spaced as to take up the full tensile stress when the tank is full of water; and not permitting any of the tensile stress to be taken up by the concrete.

In addition to these horizontal rings in that part of the shaft forming the wall of the tank, vertical reinforcing rods of ½ in. bars were also placed 16 in. apart. The dome-shaped bottoms and walls of that part of the shaft forming the tanks were made of 1:1½:2½ mixture. The thickness of the concrete walls of the shaft are as follows: 9 in. at the top of foundation and gradually decreasing to 8 in. at a height of 66 ft. above the ground line, which thickness continues to the widening required for the tank bottom.

The wall of the 50,000 gal. tank is 9 in. thick, and that of the upper, or 100,000-gal. tank, is 7 in.

The size of gravel used in the foundation was 2 in. and under; in the

shaft supporting the tanks 1 in. and under; and in the dome-shaped bottoms the shaft forming the tanks ½ in. and under.

The roof is conical, and it also has a tendency to flatten; that is taken care of by additional horizontal rings in the walls of the shaft in the same manner as the tank bottoms. The reinforcement in the roof consists of sheets of 3 in. mesh, No. 10 expanded metal embedded near the center of the slabs.

A portion of the shaft beneath the tanks is lighted by windows 8x30 in., arranged in the form of a spiral, each window being 8 ft. higher than the one preceding and 20 degrees in advance. In each of these window openings a pane of double thick glass has been placed and securely fastened with neat cement mortar. Three large windows and a panel door have been provided at the bottom of the tower, to make that portion serviceable as a storage room. The whole structure is neat and pleasing in appearance and resembles somewhat an ancient tower.

The riser pipes are carried up inside the tower and directly through the bottoms of the tanks. Access is had to the tanks by an iron ladder, which runs on the outside of the tower from the bottom to the top and extends down on the inside to the bottom of each tank. Openings are provided at three places along this ladder, with platform and guard rail to permit safe passage in and out. The lower opening, about 75 ft. above the ground, is at the level of the fire alarm bell and its electro-mechanical striking apparatus. The second opening is just below, and the third just above the 50,000-gal. tank. In addition there is an opening through the roof to the 100,000-gal. tank.

Lightning protection is provided by 10 rods of ¾ in. solid copper, set 2 ft. in the concrete, and extending 5 ft. above the parapet, each of these rods terminating at the upper end in a three-point aigrette. The lower ends are wired to the reinforcing and in addition are sweated to a stranded copper wire cable. This forms a complete circle just above the concrete, and is in turn connected to a similar cable embedded in the concrete just at the base of the lower tank. The bottom cable is connected to the expansion joint of the 12 in. riser pipe which acts as a ground.

The tanks are supplied by electrically-driven pumps, and these are controlled automatically. In addition, metal indicators are provided on the outside to show correctly the amount of water in the tanks.

It might be interesting to know that when water was first turned into the tanks a considerable number of small leaks developed in the sides, evidently due to not using sufficient care in cutting the wires which held the forms together. These, however, rapidly took up and in a couple of months the tanks became entirely water-tight.

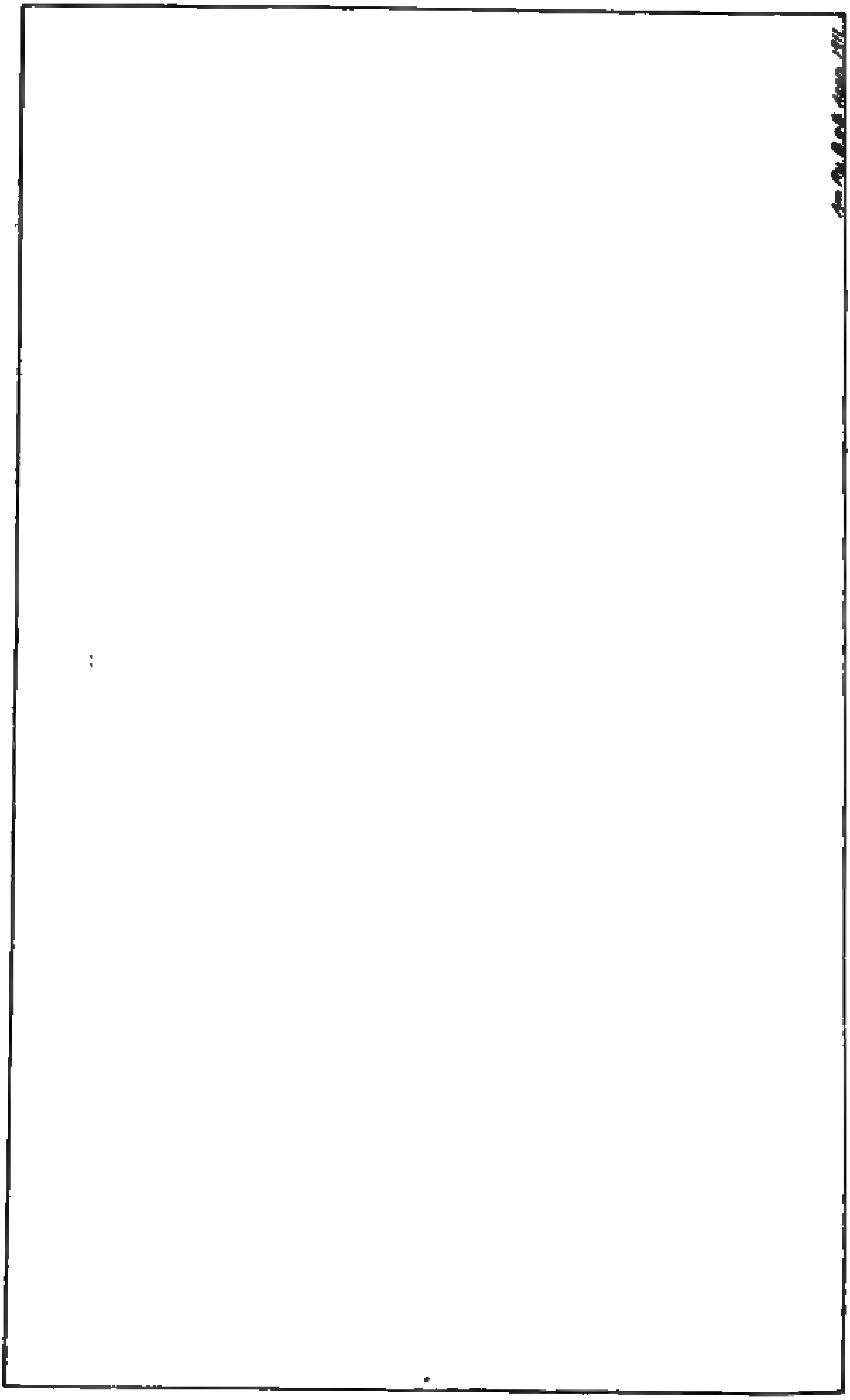
The concrete work was done by the Piedmont Construction Co., Atlanta, Georgia. The average force employed was 16 men, including the foreman, and a carpenter. The metal forms which were used are of patented design. Only one form or course was poured each day, the remainder of the time being spent in removing the forms set the day before and putting them in place for the next pouring.

The entire work was carried out under the railway company's chief engineer, Mr. C. K. Lawrence.

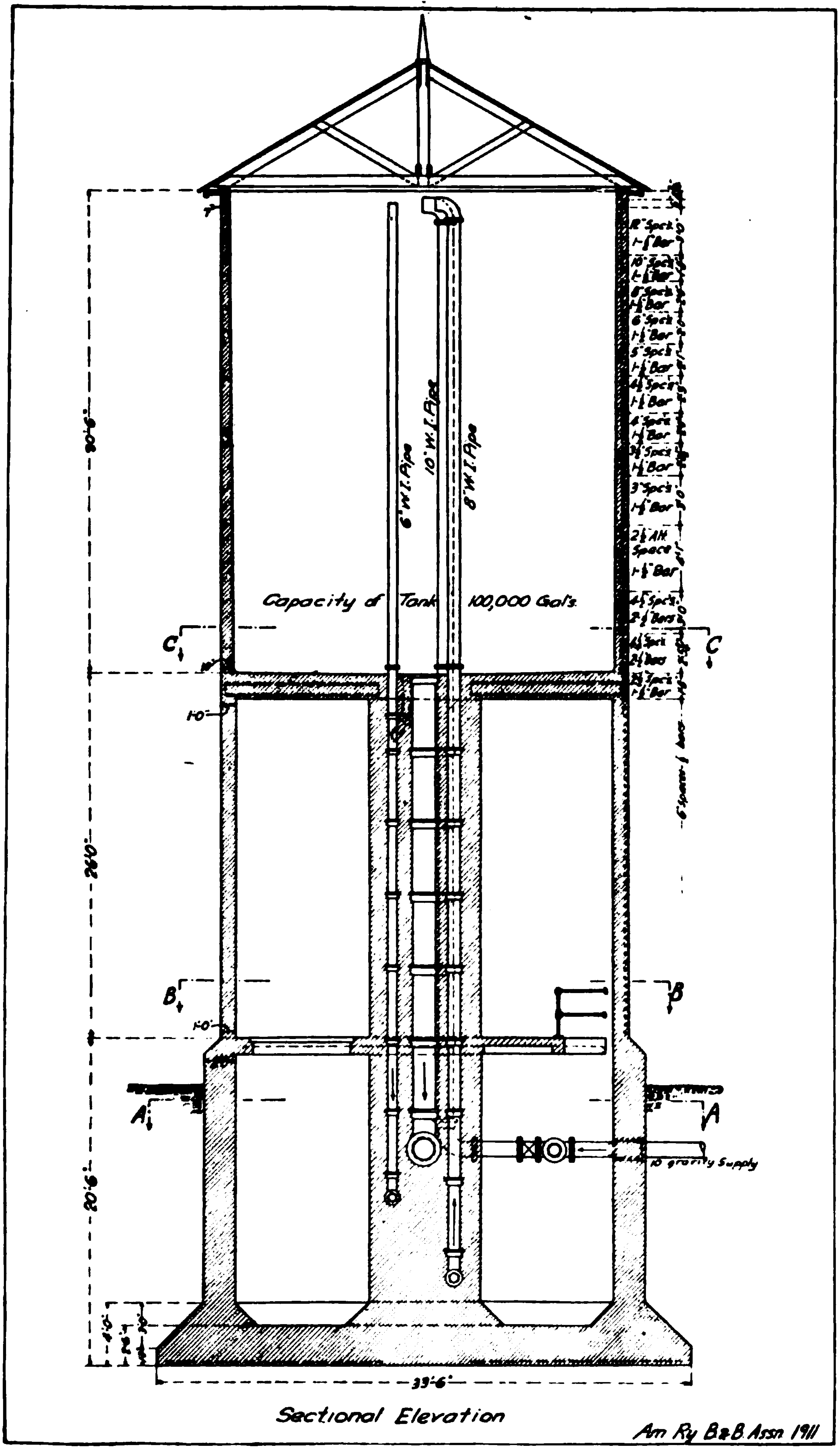
The Baltimore & Ohio R. R. completed this year a reinforced concrete water tank 24 ft. in diameter and 30 ft. 6 in. deep, having a capacity of 100,000 gallons, at Sir John's Run, W. Va., at a cost of about $7,500, exclusive of piping. Mr. W. F. Strouse, Asst. Engineer, sent a blue print and makes the following report:

The bottom of the tank is thirty feet above top of rail of the adjacent main tracks. Below the track level a basement was provided in which is located a pump, arranged for taking water from the Potomac river in case of failure of the gravity supply. The space between the track level and the bottom of the tank is arranged for a storeroom for supplies required about the coaling and water stations. The enclosed plan fully illustrates the arrangements and shows details of construction.

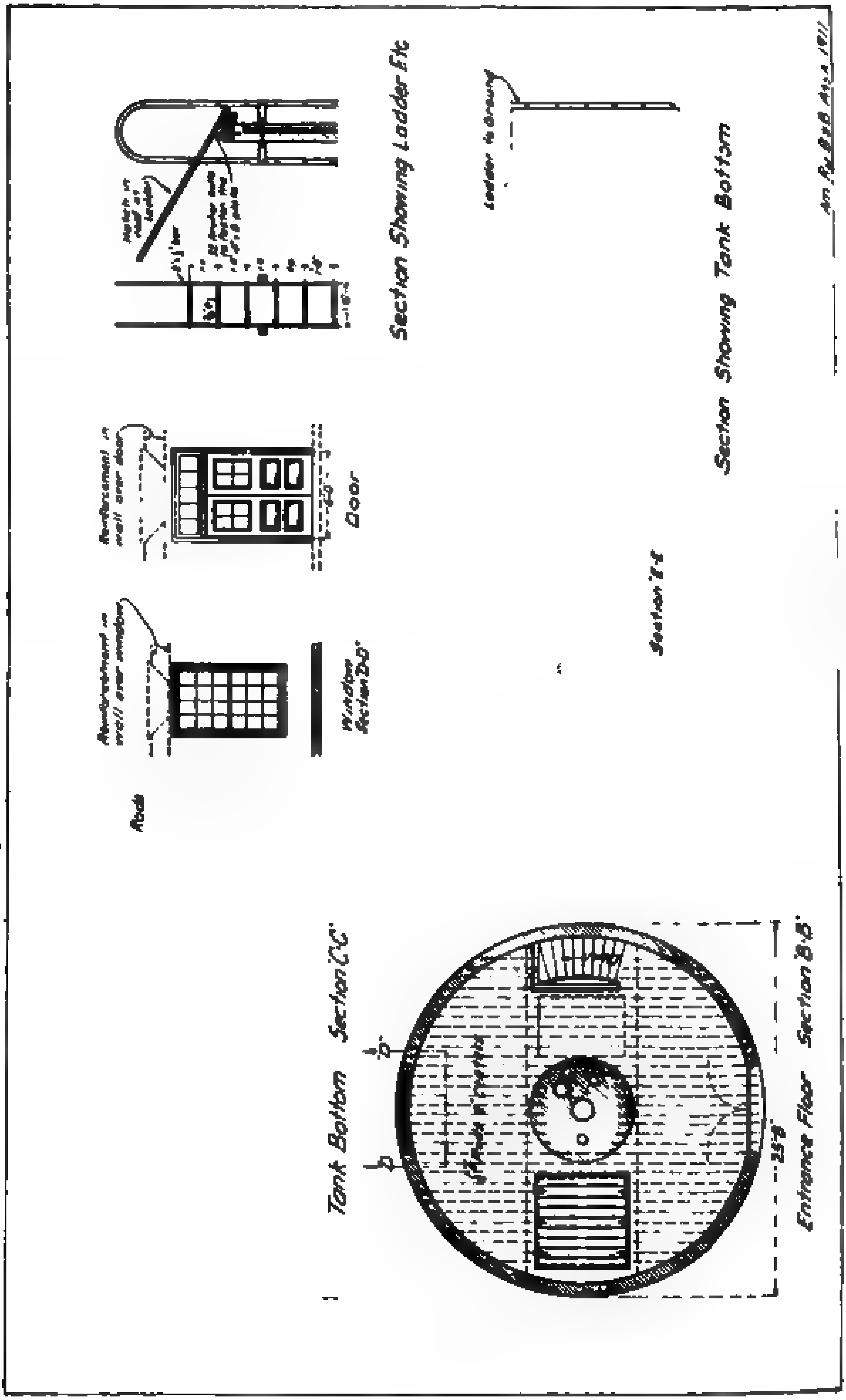
The foundation and walls below the track level were constructed of plain concrete, of a 1:3:5 mixture. All work above the track level was rein-



Concrete Tank, Sir John's Run, W. Va., B. & O. R. R.



Concrete Tank at Sir John's Run, W. Va., B. & O. R. R.



Details of Concrete Tank at Sir John's Run, W. Va.—Baltimore & Ohio R. R.

forced concrete of a 1:2:4 mixture, the ingredients being Portland cement, crushed washed glass sand and crushed limestone which would pass a one inch ring. The walls were moulded in forms constructed of sheet steel after patents of the Steel Concrete Construction Company, and they produced a smooth surface except at the horizontal joints, at intervals of about five feet, where a slight lipping occurred due to a small discrepancy between the shape of the top and bottom edges of the forms. The bond at the horizontal joints was formed by cleaning the top surface of each section with wire brushes and clean water. The surface was then covered with a thin grout of hydrated lime, Portland cement and sand, followed by a coating of mortar before the concrete for the next section was poured.

Corrugated steel bars spaced and bent to proper radius, as shown on the plan, were used for the reinforcement. They were lapped 30 diameters and wired together with No. 12 annealed wire at all joints.

The waterproofing consisted of hydrated lime mixed with the cement in the proportion of not to exceed 5 per cent by volume. The exterior walls were painted two coats of Bay State cement coating of a light gray color.

Mr. H. H. Kinzie, Supervisor B. & B., N. Y., N. H. & H. R. R., sends the following interesting report of experience with a standpipe built for the town of Attleboro, Mass., 50 ft. in diameter and 100 ft. high, that is giving entire satisfaction:

The Aberthaw Construction Company, of Boston, Mass., erected this standpipe, and it is said that it is one of the largest reinforced concrete standpipes yet constructed. The walls are 18 in. thick at the bottom and 8 in. at the top. The foundation extends to a solid subsoil at a depth of 7 ft. The bottom pan and the walls are connected by a reinforced fillet of good size. The concrete used was a 1:2:4 stone mixture. The horizontal steel reinforcement consisted of 1½ in. plain round bars in double vertical rows extending from the ground to a height of 60 ft. Above this a single row was used which, at 81 ft., was reduced to 1⅛ in. diameter. The steel is protected throughout by from 2½ in to 3 in. of concrete. The spacing of the double horizontal steel members varies from 3¾ in. c. to c. to 8 in.; that of the single 2½ in. row, 4⅛ in. to 6 in.; and that of the 1⅛ in. row, 3½ in. to 6⅝ in., on centers. These bars were delivered in lengths of 56½ ft., necessitating the use of three to span the circumference with an overlap of 30 in., each, with which to clamp them together. The vertical reinforcement consists of fifteen channels, equally spaced. These were drilled at intervals for the reception of short ½ in. bars upon which to rest the horizontal bars.

On Dec. 27, 1905, the new standpipe was put into commission and we continued to use the same until May 15, 1906. The leaks during that time were very trifling, although during extreme cold weather there was noticed a peeling off on the outer surface at certain points, beginning five feet from the bottom of the tank and extending to a point about 15 ft. above it. This was apparently caused by pockets or cavities that must have existed on the outside of the steel, probably caused by the slight moving of the forms when the concrete was being placed.

About May 15, 1906, the Aberthaw Construction Company began the plastering on the inside of the standpipe. The first coat had 2 per cent of lime to one part cement and one part sand; the other three coats were composed of one part sand and one part cement. This was floated until a hard, dense surface was produced. Then this surface was scratched to receive the succeeding coat. This work was done by experts in that line.

Prior to the plastering the entire inside of the standpipe was thoroughly cleaned and then picked. This was done to insure the bonding of the cement plaster to the surface. There were four coats of plaster put on, and they felt reasonably sure that it would be perfectly tight, as great care was used in applying the coatings. Upon filling the standpipe, however, it was found that the work did not give the result expected, as the builders had felt positive that they should have an absolutely water-tight structure.

At the time the inside work was being done the outside, where the cement had scaled off from the effects of frost, was repaired by digging around the outside row of steel reinforcement, putting on iron clips made of ¾x1⅛ in.

iron bolted through, and then cement was forced into the cavities around these clips by throwing it at a distance of four or five feet to insure the filling of the voids. This process was continued until the cement covered the entire outer surface, so that further plastering could be perfectly bonded. On this surface was placed expanded metal, forced over the clips that stood out horizontally, and then a coat of plaster was carefully troweled over the surface of this metal, and next a coat of metal placed outside of that plastering, the ends of the clips being turned at right angles to hold the same in place. After this the final outside coat was applied, thus making a very firm and compact surface equal to any part of the structure.

After noting the result of the interior plastering, they were satisfied that some other method must be used to make the standpipe perfectly tight under the 100 ft. head, at the same time realizing that in a warmer climate they should not hesitate to accept it as it was. On consulting with their engineer and contractor they decided to coat the inside with what is known as the "Sylvester Process" wash. I presume many of you are familiar with the same, but for the benefit of those who are not, I will give the formula used on this standpipe:

Dissolve ¾ pound castile soap in one gallon of water. Dissolve one pound pure alum in eight gallons of water. Both must be thoroughly dissolved. Before applying to the walls, the surface must be perfectly clean and dry. The temperature must be about 50 degrees, Fahrenheit. First, apply the soap at boiling temperature with a flat brush, taking care not to form a froth. Wait 24 hours, so that the solution will become dry and hard upon the walls, and then apply the alum in the same way, at a temperature of 60 to 70 degrees, Fahrenheit. Wait 24 hours, and repeat with alternate coats of soap and alum.

On the Croton work four coats of each solution rendered the walls impervious. According to report a pound of soap will cover about 37 sq. ft., and one pound of alum will cover about 95 sq. ft. Water was admitted to the tank as soon as the last coat became hard and dry. This solution has been used with good success on a number of reservoirs, not exceeding a 40 ft. head, making them absolutely tight.

In order to test this process they decided to try 35 ft. of the standpipe from the bottom up. After applying four coats of the mixture they filled the standpipe full at 100 ft. head and they found there were only four leaks in the 35 ft. coated. On account of this success they decided to apply four coats more to this same surface, that making eight coats from the bottom up to 35 ft., and above that distance four coats. The result was very satisfactory, but still the standpipe was not absolutely tight. They then decided to apply five more coats over the entire surface, thus making thirteen coats for 35 ft. and nine for the rest of the structure. On Oct. 28 the standpipe was filled and found to be practically tight, and has given them very little trouble, if any, since it was put into service.

In 1909 the Ann Arbor Gas Company, at Ann Arbor, Michigan, built two rectangular ammonia storage tanks of reinforced concrete, having a common wall. The larger tank is 40x10 ft. 1½ in., with a capacity of 27,850 gal., and the smaller is 30x8 ft. 1½ in., with a capacity of 17,000 gal. Both tanks are 13 ft. deep. In the building of these tanks quick sand and water were encountered and it was necessary to lay drains under the entire tank bottom and pump water during the period of construction.

These tanks were reinforced with trussed bars laid in both directions and bent rods carried from the walls into the bottom. After completion the inside was white-washed with a cement coating and after that plastered with a thin coat of cement mortar, consisting of one part of sand to one part of cement. These tanks have proven very satisfactory and are apparently absolutely water tight. The cost of both tanks was about $1,700.

The Metal Concrete Construction Co., of St. Louis, completed a reservoir for the Virginia Electric Power & Water Co., at Virginia, Minn., last fall, 45 ft. diameter, 21 ft. high. It is built partly above and partly below the ground level, and during the winter the exposed portion was covered with a layer of clay next to the tank, a layer of cinders above that and then another

layer of clay, making a total thickness of 18 inches. When the covering was removed in the spring the tank showed no sign of injury by frost, although the winter was severe. As far as can be seen, the concrete is perfectly water tight.

On the eastern division of the Pennsylvania Lines, between Alliance and Galilee there may be found a number of reinforced concrete tanks on reinforced concrete posts.

On Jan. 1, 1909, the Grand Rapids & Indiana Ry. put into service at Elmira, Mich., a tank of 50,000 gal, capacity, having a reinforced concrete substructure and floor with wooden staves. It has been in service continuously since it was erected and is reported as giving the best of satisfaction. While not exactly in line with the subject, it is included in this report as an item of interest. The joint between the wooden staves and the concrete floor was first calked with oakum and then filled with hot pitch.

There is no question but that interest in the use of reinforced concrete in the construction of water tanks is increasing. The committee has had many replies from members of this association stating that they have had no experience in this line, but that the matter has been under consideration.

Mr. C. H. Fisk, chief engineer of the Tennessee, Alabama & Georgia Ry., writes that he is interested because his road is contemplating the erection of ten such structures, and he may be able to add some valuable information in the future.

List of some of the principal reinforced concrete tanks, standpipes and reservoirs built in the U. S. with reference as to where detailed information may be obtained.

1899—Little Falls, N. J. Standpipe. 10 ft. dia., 43 ft. high. Cap. 25,000 gal. Trans. Am. Soc. of C. E., Vol. 50, p. 454; Vol. 54, Part E., p. 433.

1903—Milford, Ohio. Standpipe. 15 ft. dia., 81 ft. high. Cap. 93,000 gal. Engr. News, Vol. 51, p. 184, Feb. 25, 1904. Engr. Record, Vol. 49, p. 382, March 26, 1904.

1903—Fort Revere, Hull, Mass. Standpipe. Octagonal Tower, 33 ft. dia., 84 ft. high. Tank 20 ft. inside dia., 50 ft. high. Cap. 118,000 gal. Journal of New England Water Works Ass'n, March, 1905. Engr. News, Vol. 52, p. 596, Dec. 29, 1904. Engr. Record, Vol. 48, p. 218, Aug. 22, 1903. Municipal Jour. & Engr., Vol. 21, p. 543, Dec. 5, 1906. Cement Age, p. 353. Feb., 1905.

1904—Attleboro, Mass. Standpipe. 50 ft. dia., 100 ft. high. Cap. 1,500,000 gal. Engr. News, Vol. 57, p. 212, Feb. 21, 1907. Engr. News, Vol. 62, p. 199, Aug. 19, 1909. Cement & Engr. News, Vol. 19, p. 138, June, 1907. Jour. of Ass'n of Engr. Soc., Vol. XLVI, p. 402, June, 1911. Engineering-Contracting, Vol. 35, p. 560, May 17, 1911.

1905—Hampton, Va. Two Tanks. Each 26 ft. 6 in. dia., 16 ft. high. Cap. 66,000 gal. Trans. Am. Soc. of C. E., Vol. 54, Part E, p. 433.

1905—Bordentown, N. J. Water Tower. Engr. Record, Jan., 1906, p. 39.

1906—Anaheim, Cal. Tank. 26 ft. dia., 30 ft. deep, resting on 60 ft. concrete tower. Cap. 172,000 gal. Engr. Record, Vol. 56, p. 203, Aug. 24, 1907. Municipal Journal & Engr., Vol. 28, p. 366, March 9, 1910, and p. 527, April 13, 1910.

1906—Kansas City, Mo. Tank. On tower above warehouse. Cap. 25,000 gal. Engr. News, Vol. 58, p. 82, July 25, 1907.

1906—Waltham, Mass. Standpipe. 100 ft. dia., 37 ft. deep. Cap. 2,000,000 gal. Jour. of Ass'n of Engr. Soc., Vol. XLVI, p. 421, June, 1911. Engr. Record, Jan., 1907, p. 32.

1907—Lincoln, Me. Tank. 32 ft. dia., 16 ft. deep. Cap. 108,000 gal.

1908—Atlanta, Ga. Tank. Resting on chimney-like shaft. Cap. 100,000 gal. Engr. News, Vol. 61, p. 22, Jan. 7, 1909. Engr. Record, Vol. 59, p. 9, Jan. 2, 1909.

1908—New Haven, Conn. Standpipe. 50 ft. dia., 25 ft. high. Cap. 375,000 gal. Engr. News, Vol. 59, p. 191, Feb. 20, 1908.

1909—Empalme, Sonora, Mexico. Standpipe. 30 ft. dia., 90 ft. high.

Cap. 475,000 gal. Engr. News, Vol. 62, p. 635, Dec. 9, 1909. Mun. Jour. & Engr., Vol. 28, p. 828, June 8, 1910. Railway Age-Gazette, Vol. 47, p. 469, Sept. 10, 1909.

1909—San Francisco, Cal. Two Tanks. Each 17 ft. dia., 20 ft. deep. Cap. 32,400 gal. 14 ft. above ground carried on 4 in. reinforced concrete slabs. Engr. Record, Vol. 61, p. 726, June 4, 1910.

1909—Cajame, Sonora, Mexico. Tank. With dome supported bottom. Cap. 60,000 gal. Engr. Record, Vol. 61, p. 248, Feb. 26, 1910.

1909—Montview Station, Va. Tank. 30 ft. dia. Cap. 100,000 gal. Engr. Record, Vol. 60, p. 447, Oct. 16, 1909.

1909—Bridgewater, Mass., State Farm Standpipe. 30 ft. dia., 78 ft. high. Cap. 413,000 gal. Jour. of Ass'n of Engr. Soc., Vol. XLVI, p. 399, June, 1911.

1909—Manchester, Mass. Standpipe. 50 ft. dia., 72 ft. high. Cap. 1,060,000 gal. Jour. of Ass'n of Engr. Soc., Vol. XLVI, p. 399, June, 1911.

1909—Lisbon Falls, Me. Standpipe. 50 ft. dia., 62 ft. high. Cap. 913,000 gal. Jour. of Ass'n of Engr. Soc., Vol. XLVI, p. 398, June 1911.

1909—Spokane, Portland & Seattle Ry. Tank. 24 ft. dia., 16 ft. high. Cap. 48,000 gal. Ry. & Engr. Review, Vol. 49, p. 852, Sept. 25, 1909.

1909—Ann Arbor, Mich. Two Rectangular Tanks. 10 ft. x 40 ft., 13 ft. deep. Cap. 27,850 gal.; 8 ft. x 30 ft., 13 ft. deep. Cap. 17,000 gal. Engr. Record, Vol. 64, p. 481, Oct. 21, 1911.

1910—Westerly, R. I. Standpipe. 40 ft. dia., 70 ft. high. Cap. 650,000 gal. Canadian Engineer, Vol. 19, p. 430, Sept. 29, 1910. Engr. Contracting, Vol. 34, p. 284, Oct. 5, 1910. Engr. Contracting, Vol. 36, p. 371, Oct. 11, 1911. Jour. of Ass'n of Engr. Soc., Vol. XLVI, p. 404, June, 1911. Proc. Am. Soc. C. E., Vol. 37, p. 1025.

1910—Rockland, Mass. Standpipe. 46 ft. dia., 104 ft. high. Cap. 1,300,000 gal. Jour. of Ass'n of Engr. Soc., June, 1911.

1910—Cherry Valley, Mass. Standpipe. 40 ft. dia., 21 ft. high. Cap. 200,000 gal.

1910—Rockdale, Mass. Standpipe. 40 ft. dia., 21 ft. high. Cap. 200,000 gal.

1910—Kensington, Conn. Reservoir. 50 ft. dia., 21 ft. high. Cap. 300,000 gal. Engr. Record, Vol. 63, p. 183, Feb. 18, 1911.

1910—Waverly, Ohio. Standpipe. 22 ft. dia., 82 ft. high. Cap. 120,000 gal. Engr. Record, Vol. 64, p. 137, July 29, 1911. Cement Age, Vol. 13, p. 18, July, 1911.

1910—Virginia, Minn. Reservoir. 45 ft. dia., 21 ft. deep. Cap. 250,000 gal.

1911—Ashland, Mass. Standpipe. 40 ft. dia., 32 ft. high. Cap. 300,000 gal.

1911—Key West, Fla., U. S. Naval Station. Standpipe. 80 ft. dia., 40 ft. high. Cap. 1,500,000 gal. Engr. News, Vol. 65, p. 492, April 20, 1911.

1911—Savannah, Ga. Tank. Tower 187 ft. high tapering from 35 ft. dia. at ground line to 25 ft. in dia. at top. 2 water reservoirs, one above the other. Total cap. 150,000 gal. Engr. News, Vol. 66, p. 260, Aug. 31, 1911.

1911—Sir John's Run, W. Va. Tank. 24 ft. dia., 30 ft. 6 in. high. Cap. 100,000 gal.

Reference Books.

"Concrete Construction, Methods and Costs," by H. P. Gillette and C. S. Hill. "Reinforced Concrete for Standpipes and Tanks," by Charles B. Burdick. "Water Storage in Elevated Tanks and Standpipes," by H. E. Horton.

Journal of the Western Society of Engineers, Vol. 14, p. 129, June, 1909. "Concrete and Reinforced Concrete Construction," by Homer A. Reid. "Concrete—Plain and Reinforced," by Taylor & Thompson. "Hand Book of Cost Data," by H. P. Gillette. "Engineer's Pocketbook of Reinforced Concrete," by Lee Heidenreich.

DISCUSSION.

The President:—We will discuss the report of the committee on concrete tank construction. Mr. F. E. Weise is chairman.

Mr. J. H. Markley:—Has the committee any information in regard to cost, as compared with the cost of iron and wooden tanks?

The President:—I believe they have.

Mr. Weise:—In some of the descriptions that accompany this paper, statements of the cost have been given, but the committee did not go into the matter of cost with a view to making a complete analysis of it, because the conditions in the individual cases that we were able to get at vary so much that we could not obtain any good figures, or figures that one could apply somewhere else. It is generally admitted, however, that the reinforced concrete tank costs considerably more than either a steel or wooden tank, but its permanent construction and the low cost of maintenance is the big argument in its favor.

The President:—Now Mr. Markley, we would like to hear from you; Mr. Aaron Markley.

Mr. A. S. Markley:—As I have never seen a concrete tank, I hardly know of any argument for or against it. It is something new to me and I am just waiting to hear what the others have to say. I may have something to say on the subject later.

The President:—Are there any other members present who are familiar with this form of construction?

Mr. Strouse:—I sent to the committee a drawing and a brief description of the tank that was constructed for the Baltimore & Ohio R. R. I do not know that I have anything more to say than was given in that description. The tank has been in use only some three or four weeks, and we have not had time to determine definitely on the waterproofing features. So far, it has not leaked. It has sweated a good deal and, of course, has discolored the outer surface. In this particular tank the forms were of interest to me, in that two concentric metal forms were used and a section of about five feet was constructed at a time. As the concrete hardened, it was allowed to stand about a day, the forms were loosened and raised up and supported; that is, separated by separators which were removed as the next section of concrete was placed. In the report I made mention of the method of joining the new concrete to the old.

The only effort made there to get a perfect bond was to clean the top surface of the previous section thoroughly with wire brushes, and then to place on that surface a grout of cement and a small quantity of hydrate of lime. Each section required about two days; that is to say, one day for filling the section and one day for the material to harden and to move the forms. The water was not turned into the tank for about thirty days, and when it was first turned on several small leaks developed, but lately nothing has shown up that would indicate that the tank is not substantially water tight. As I say, a small amount of moisture has gathered on the outside, that has followed down the walls and discolored the paint that was applied to the outside, but I am of the opinion that this particular style of tank construction is good; it is bound to be reliable and economical. Of course it is more expensive than wooden or steel tanks at first cost, but I think it will be cheaper in the long run.

Mr. O'Neill:—I would like to ask the gentleman if the leaks developed at the meeting points of the partly dry joints, or did they develop through the body of the concrete that was deposited during the day.

Mr. Strouse:—Apparently the moisture comes through the concrete indiscriminately; it don't seem to come through at the joints any more than at any other place.

Mr. O'Neill:—Tell us what the mixture was.

Mr. Strouse:—One to four, with approximately five per cent of hydrate of lime.

Mr. O'Neill:—How wet was that mixture?

Mr. Strouse:—Quite wet—so that in pouring it could be thoroughly stirred around.

Mr. O'Neill:—It would appear, then, that we would need something in the way of waterproofing besides a good, fairly rich mixture of concrete, in order to hold water.

Mr. Strouse:—I have always felt so; yes, sir.

Mr. O'Neill:—I too think so.

Mr. Sheldon:—I notice that in most of those tests it says that sharp sand shall be used, without designating whether it shall be coarse, fine or medium. There is a very great difference in the character of the voids in sand. What we call very fine sand has voids of nearly 50 per cent. A clean sand of varying texture, running rather to the coarse, will sometimes have as low as 10 per cent of voids. This fact might have a bearing on the quantity of cement required and also on the waterproofing qualities of the tank. In oth-

er words the texture of the sand used is important. I think the Universal Portland Cement Co. has made some exhaustive tests with different grades of sand and it might be interesting to get the result of those tests. I think they have found also that too little moisture is objectionable; and so is too much; so that when the water has evaporated, the space occupied by it is there and will be filled by other water when the tank is full. I think that it is possible to have the mixture too wet, as well as too dry.

Mr. Strouse:—We used what I think was termed No. 3 sand from a sand works right in the vicinity of where this work was done. It is really a glass sand. The rock is excavated from the hills and crushed and washed, and in the disposition of this sand they have several grades: one a very fine sand that is used by the glass companies, and another that is considerably coarser and not quite as clean as the glass sand. We used sand that had a slight amount of coloring matter in it, and of a grade that is not generally used by the glass manufacturers. I would say that the sand is probably of the character that Mr. Sheldon has in mind—a sand that contains quite a quantity of very fine particles resulting from the operation of crushing it; and then, with that, a coarser grade.

The President:—Has some one else any direct information or experience in regard to that type of construction?

Mr. Weise:—Some inquiries have been made regarding the thickness of the walls. In the first place, before we leave the sand question, I notice that in every specification that is given the proportions of cement, sand and gravel vary. I think that is largely due to local conditions; that the people who have it in charge will vary their proportions according to the material they have to work with. Sometimes one cannot get just the kind of sand that is wanted. I know that on our road, the Chicago, Milwaukee & St. Paul Ry., we are obliged to vary the proportions because we sometimes cannot get the kind of material desired without hauling it long distances.

In the matter of thickness of walls there is much difference of opinion. In some cases walls are made very thick, while in other cases they are very thin. There are shallow tanks where the walls are only three inches thick at the top and six inches at the bottom, and they may vary from six to ten inches at the bottom. In some of the higher towers the walls are as thick as 18 inches at the bottom. That is a matter of design and has to be figured out by the individual who is building the tank. It is usually allowed that the reinforcement will take care of the tension or stress in the walls, and

they don't figure very much on the strength of the concrete to resist tension, because, where the depth of water gets to be about 50 feet or so, the pressure exceeds the tension that the concrete will stand.

The usual experience leads us to this, that the tendency of the tank, when it is filled with water, is to expand; and, naturally, where the pressure is great enough, the concrete will have to give to a certain extent and will form very minute cracks, sometimes very close together; in fact the cracks are so small that they cannot be seen with the naked eye, and can be observed only after the tank has been emptied by noticing little lines of water along the surface of the concrete. These cracks, while they are not serious, allow some water to seep through, but after a while these spaces fill up, and in most of these descriptions you will find that during the first few weeks there was a slight seepage at the base of the tank, which afterwards disappears.

Mr. J. H. Markley:—I do not wish to criticise Mr. Strouse's method of putting up a tank, but if I were doing it I believe I would make the concreting continuous, and not stop until the entire volume was poured and the tank completed. There is a danger in uniting new and old concrete that no man can foresee or foretell. Of course there are some who can do that and do it properly, while there are a great many who cannot. It can be done by erecting either the outside or inside casing clear to the top, and in either case there is a section of two, three or four feet, just high enough so that the workmen can spread down in and keep adding to the wall as they build up, and keep that going continuously until the tank is completed.

I do not recall that any one mentioned using washed sand, which is the kind that should be used in work of this character. Clay and other foreign matter should be excluded. Clay would be especially dangerous in a structure of this kind, while in heavy work it might not be so considered.

Mr. Strouse:—What Mr. Markley has said in regard to continuous operation might apply in shallow tanks. I am somewhat in doubt, however, as to the result he would obtain where the tanks were deep. The tank in question was 30 feet high, and I am of the opinion,—in fact, I am quite well satisfied,—that if the forms had been placed at one time and had been filled entirely from the top, that we would have gotten poor results. My reason for this belief is that a few years ago we had a piece of work where deep girders were covered with concrete. Reinforcing rods ran along the side of the girder, through which were passed stiffeners. The forms were

built the entire depth of the girder, about 10 feet. Concrete was poured in from the top, and it was supposed to have been distributed evenly along the length of the girder. Some six months or a year after this work had been completed we discovered some cracks forming along the bottom of the girder, on the lower flange. Upon investigation, we found that the material encasing the bottom of the girder was composed principally of sand and cement, with very little or no stone. Apparently, in pouring the concrete to the depth of ten feet through the reinforcing rods, the stone had been prevented from following down with the concrete, and the result was that we got plenty of stone in the upper portion of the structure, but practically none in the bottom, and, for some reason or other, the white substance that collects on the surfaces of freshly placed concrete, had collected at places in the bottom portion of this work, which rendered the concrete practically useless. We had to remove a great deal of it, and I am very strongly of the belief that if an effort were made to pour concrete from the top for a depth of even 20 feet, that the same thing would happen.

I would say further that this particular construction was cheapened by the use of the steel forms. A section about five or five and a half feet was used and the taper was formed by placing thin sheets of metal over the joints and tightening up or loosening the bolts to the proper perimeter. When the work was completed, the forms were taken down and they will be good for the building of a great many tanks, which, of course, will cheapen the cost of other tanks to be built by the concern that constructed the one for our road.

Mr. J. H. Markley:—Mr. President, I believe that Mr. Strouse misconstrued my meaning. It was my idea to use two, three, or four sections at a time and keep building up, and not to pour it from the top. I had occasion two years ago to encase a pier thirty feet high and eighteen inches thick with concrete, and I used that method in doing the work. We began in the morning and kept on continuously till the second morning, when the work was completed. We experienced no trouble whatever and found no evil results. I believe that could be accomplished with proper bracing up, in the case of a tank, using the movable sections either on the inside or outside and make the fall of the concrete not so far as it would be from the top, say three, four or five feet.

Mr. O'Neill:—I would like to ask, if the small cracks developing in the concrete would not be disastrous to the steel reinforcement? It seems to me that it would be if the water came in contact with the steel that we get nowadays for that purpose.

Mr. Weise:—I do not know. That is a part of the subject that nobody mentioned and I have not thought of seriously, but the cracks that I spoke of, that develop from expansion at the bottom, and the concrete is stressed beyond what it will stand, are very small, infinitesimally small; in fact so small that one cannot notice them; only that after the tank is empty, one can notice along the surface, little wet lines that show where the water is oozing out because the concrete is coming back into place. I don't think that enough water is in there to do any harm to the steel, as those cracks gradually fill up with sediment or deposits from the water. There is a chance, however, that if the concrete is not properly placed, little pockets will form along the line of reinforcement that may eventually result in the corrosion of the steel or result in cracks larger than those I speak of, but that would be owing to a fault in workmanship.

The President:—A relative of mine designed a tank in Wisconsin for an industrial concern, and, as we all know, industrial concerns usually take up such things quicker than railroads do. This tank was about sixty feet high—thirty feet in the ground and thirty feet above ground. The portion under ground was not reinforced, but that above ground was. The tank is giving excellent service. It was about twenty-four feet in diameter. I cannot tell you anything about the thickness of the walls. I have seen it only once and did not pay much attention to it.

What is the pleasure of the convention? Is it your desire to continue the discussion of this report, or shall we drop it here and continue the subject for next year? We all agree, I think, from the discussion that we have had, that the construction of concrete tanks is rather in its infancy, as yet, and that developments are coming right along; that is, it is a very live subject for us to continue to investigate.

Mr. J. H. Markley:—I believe it would be wise to continue it.

The President:—Will you make that in the form of a motion?

Mr. Markley:—Yes sir.

The President:—It has been moved and seconded, gentlemen, that this subject be continued for further investigation. I would suggest to the incoming president that he retain Mr. Weise as chairman of that committee.

The motion was carried.

SUBJECT NO. 9.

BRICK VENEER FOR STATION BUILDINGS.

REPORT OF COMMITTEE.

The committee sent out a letter to members of the association and others asking what results they had secured from using brick veneer for station buildings. The replies indicate that but very few roads use brick veneer to any extent for this purpose, and a large number advise that they have not had any experience with that type of structure. Several members of the committee have had no experience with brick veneer, and one who had some experience has had considerable trouble with the veneer jarring loose from the wood work, especially around the window and door frames, on account of the vibration from passing trains and the generally severe service a station building has to withstand.

Taking into consideration the cost of lumber and the additional expense for a suitable foundation which would withstand the vibration caused by the passing of high-speed trains, many of the members are of the opinion that the saving of the cost of brick veneer over that of a solid brick structure would not justify veneering. This also brings up the question of the advisability of placing a brick veneer building on an expensive foundation.

As for fire protection, it is not considered that brick veneered buildings are very much superior to ordinary frame structures, as but a small percentage of fires that damage or destroy buildings have their origin in the outside walls.

The Toledo, Peoria & Western Ry., the Chicago, Burlington & Quincy R. R., and other roads are constructing such buildings, and consider them as being in line with good practice. A number of letters have been received, giving the experience and opinions of members, in connection with this subject and we would recommend that they be published as a part of this report in order that the association receive the benefit of all that has been offered in connection therewith.

EXTRACTS FROM LETTERS.

C. F. Loweth, C. M. & St. P. Ry.:—We have very few buildings of this character on our system, and it is seldom that this form of construction is considered advisable. When lumber was cheap a brick veneer building cost much less than one with solid brick walls, but now that the price of lumber is very much higher there is not enough difference in cost to justify the former. The brick veneer building has practically two walls, the outer of brick and the inner of frame, thus making the structure less stable than one built entirely of brick or of wood, and the fireproof qualities are only slightly better than of a frame building.

J. H. Markley, Toledo, Peoria & Western Ry.:—We have four brick veneered station buildings and we like them so well that we are going to build another this season. Two of these cost $10,000 each. They are located at Sheldon and Watseka, Ill. Another costing $6,000 is located at Washington, Ill.

To tie the brick and the frame we use a wall tie made of galvanized iron. These are placed opposite each stud at every fifth course of brick.

J. A. Landstrand, C. M. & St. P. Ry.:—We have built station buildings with brick veneer to a limited extent, and so far as their stability is concerned we have found them satisfactory. This class of construction is not considered favorable, however, because there is little or no difference between the cost of a brick veneer building and one built with solid walls. The disadvantages in brick veneer buildings are the greater fire risk, and the fact that the cost of construction is not materially cheapened. On the other hand, there might be localities where such construction would be advantageous, on account of the lighter load on the foundation.

J. Rivett, C. B. & Q. R. R.:—About 12 years ago we built a passenger station at Plattsmouth, Nebr., which was veneered with four inches of pressed brick. This building is on a concrete foundation, and the platforms are of brick laid flat. This building stands within 18 ft. of the main line where there is heavy freight traffic and today the brick work is in good condition. After this experience we feel justified in constructing other buildings of a like character. Until the present year this was the only station of the kind on the lines west of the Missouri River.

We are now building veneered station buildings at Walthill, Alma and Harvard, Nebr., the two last named being for passenger use only, and the first named for both passenger and freight. These stations will have concrete foundations; the studs will be 2x6 in., sheathed on the outside with 1 in. boards. The brick will be laid against the sheathing and in every fourth course we drive a 16-d wire nail into each stud for a wall tie, leaving the head of the nail extend about one inch into the mortar in the joint. The heads of these nails are flattened to avoid making a large joint. The space between the brick and the sheathing is filled with mortar for a height of five feet above the platform, on account of the liability of the walls being struck by trucks, barrels and other heavy freight, which is then much less liable to injury. Angle iron guards should be put on the corners for protection.

These stations are provided with tile floors, concrete window sills and angle iron lintels.

J. M. Brown, C. R. I. & P. Ry.:—I know of but one depot having brick veneer walls. This is a very neat station, built many years ago, and is still in good condition. At this time I do not think it advisable to build frame buildings, and then veneer them with something else. Formerly when lumber was cheaper, it was advantageous to do this, but since the advance in the price of lumber and since hollow tile can be secured so cheaply, I would advise against the use of the veneer type of buildings.

M. E. Gumphrey,
J. D. Moen,
W. Beahan,
R. O. Ellictt,
W. A. Conkling,
Committee.

DISCUSSION.

Mr. Penwell:—This is a live subject to me, for the reason that we are using tile roofs to some extent. They have given such good satisfaction that we want to continue using them. We are even putting them on frame buildings but they make such buildings look a little bit cheap. Sometimes we cannot get sufficient money to erect a good solid brick building, but with brick veneer we might be able to get the outward appearance of such, together with reasonable fire protection from without, especially with a tile roof. I would like to recommend some veneered buildings to our people if I thought they would stand. I have had no experience in that direction but I

am looking for information; I had this matter in mind before the question was proposed to the committee on subjects last year. I would like to be able to get the appearance of a brick building but with a reduced cost from that for solid walls, because solid brick is too expensive.

Mr. Killam:—Along the line of the Intercolonial Ry. we have quite a number, probably 25 or 30, of brick veneered buildings. They are not satisfactory, although they have been built quite a number of years. I do not think there have been any new ones of that kind built in the last twenty-five or thirty years. They are now built of either wood or solid brick. Our terminal stations are built of solid brick, upon concrete foundations. The veneered buildings have wooden sills and very often we have to tear the brick away around the bottom to repair the foundation and that makes them unsatisfactory. Considering the price of lumber and material of various kinds we think that we can construct a solid brick building very nearly as cheap as one of frame veneered with brick.

The President:—I would like to have Mr. Markley state if the buildings referred to in the report have stone or concrete foundations.

Mr. J. H. Markley:—One has a stone foundation and the others are of concrete.

Mr. O'Neill:—I have not had any experience with veneering railroad buildings. I have built veneered buildings as a contractor and they are still standing and giving good satisfaction as dwelling houses, but I would not feel that I could recommend that class of construction for public buildings. I do not like a lath and plaster wall for the interior of a building to be used as a waiting room or passenger station on railroads. Our plans have always specified ceiling on the inside; even if we build a solid brick wall we use ceiling for an interior finish. In such cases I think there would be no economy in veneering.

I think that a station could be built with a solid brick wall and plastered inside, for less money than to build a frame structure, veneer it on the outside and ceil it on the inside with suitable material for a waiting room and then finish it in oil and varnish.

J. H. Markley:—Three of our brick veneered stations were lathed and plastered. Upon the rough coat of plaster was applied a burlap. Of course that makes it rather expensive, but our people wanted it that way and they got what they wanted. A good heavy cotton unbleached muslin is fully as good as the burlap, and not

nearly so expensive. This will keep the plaster from cracking, and paint can be applied directly over it.

I am now building a station with brick veneer at Secor, Ill., which is to be ceiled with Beaver-board; this is a material composed principally of wood pulp. It is some cheaper than the dressed and matched ceiling that has been used for that purpose for so many years, and is only about half as expensive as the plastered wall and burlap. The Beaver-board that we use runs from 30 to 36 inches wide.

Mr. Scribner:—I was surprised a short time ago to see an article in a technical paper referring to the cost of brick veneered stations. It was written by a man in the brick business, who was prejudiced in favor of his own products. He stated that the cost of construction of several buildings that he had known of being constructed of brick veneer was only about from five to fifteen per cent below the cost of a solid brick building. I had an idea that there was a greater difference between the cost of the two. The Burlington road is at present constructing two stations of this type, of which I have inspection, one at Fulton, Ill., and the other at Knoxville, Ia. I find that the cost of these is very little more than one-half what it would be for solid brick construction. However, that is not quite a fair comparison, because the stations with the solid brick walls are provided with better finishings, both inside and outside, than are these brick veneered stations. The method of constructing our brick veneered stations is to place the brick about an inch from the outside sheathing, fastening it with a metal bond, either galvanized wire cloth or a corrugated or wrinkled bond made for the purpose.

Mr. J. H. Markley:—This station at Watseka, Ill., is at the junction of the Chicago & Eastern Illinois R. R. Perhaps my brother, A. S. Markley, will tell us what he thinks of it.

Mr. A. S. Markley:—A brick veneered wall is not nearly as good as a solid wall in my estimation. Since my brother has raised the question, I will tell you what he has reference to, concerning the Watseka station. Mr. Scribner states that the Burlington road is building their stations of this kind with the brick an inch from the sheathing. Even a slight jam against the outside is liable to jar the brick loose. If I were building a veneered building I would lay the brick as close to the sheathing as possible and put mortar between, joining the brick and the sheathing as tightly as possible so that in case the brick did get a jar it would not be so liable to become damaged. The wall should be solid, at least five feet above the foundation, because freight men are liable to slam goods against it.

Veneered walls will not withstand that kind of treatment. The conditions at Watseka are such that we have experienced little or no trouble. The contents of a shot-gun were at one time accidentally discharged into the veneering and knocked out eight or ten bricks which had to be replaced. When it comes to the upper part of the building—say from the window sills up—I think that brick veneering would answer the purpose very well. The lower walls have to be made sufficiently strong to withstand the knocks from baggage and express trucks, etc.

Mr. J. H. Markley:—In the building which we are now constructing we are filling the intermediate inch space with concrete to a height of five feet above the foundation. This will make a fairly rigid wall.

The President:—I doubt the wisdom of adopting brick veneer for station buildings. I believe the discussion has brought out the fact that the saving in cost is not sufficient to warrant their use for railroad buildings. The nearest I ever got to construction of this kind was in 1905, when I designed a small suburban station building which had a solid concrete wall to the height of the window sills; above the line of the window sills it consisted of two brick walls with a two inch air space between, the walls being tied together about every fifth course. That proved to be a very warm building and yet it was not expensive. It was put up by our own forces and I always thought that buildings of that kind would be about as cheap as any and would certainly be preferable to a wooden building veneered on the outside.

Mr. J. H. Markley:—My objection to a veneered wall is that it contains so much combustible material that there is a great liability of fire. The nearer we get to incombustible construction the less the liability of trouble from fires.

The President:—Gentlemen, this report has no definite recommendation. It is a summary of the experience of various persons in connection with that class of buildings. I think that we ought to accept the report as presented.

It was so decided and the subject discontinued.

Subject No. 10.

ROOFS AND ROOF COVERINGS.

REPORT OF COMMITTEE.

The features on which this committee was asked to report are as follows:

First:—Recommend the types of roofing best suited for the different types of buildings.

(a) With special reference to kind and incline of roof.

(b) Size and location of buildings.

(c) Necessity for painting or coating at stated intervals and probability of this being done.

Second:—Fire retardant value.

Third:—Value of guarantees, especially when material is applied by others than the guarantor.

Types of roofing best suited for the different classes of buildings:

As a general proposition the roofings suitable for use on railroad structures may be divided into five classes:

1. Built-up roofs, surfaced with gravel, slag or similar material.
2. Built-up roofs, surfaced with tile or brick, set in plastic material or cement mortar.
3. Built-up roofs without gravel, slag or tile surface.
4. Prepared roofings, with either smooth, sanded, or pebbled surface.
5. Overlapping tile, slate or cement shingles. Wood shingles are manifestly unsuited for railroad structures because of the danger from sparks. Metals, other than copper or Monel metal, are unsuited, as it is practically impossible to protect them against corrosion. However, on account of the practically prohibitive cost of copper and Monel metal, the railroad companies have gone to the use of galvanized iron or tin, where a metal roof is desired. Galvanized iron, in this case, is preferable to tin, as it is easier and cheaper to lay, does not necessitate wood roof sheathing and has as long life as the quality of tin that is made now. Galvanized iron can be used without painting, but if painted will last much longer. Tin must be painted when it is put on or it will soon rust out. Galvanized iron should not be used on a roof with incline less than 6 in. to the foot, while tin can be used on a roof with any incline.

1. Built-up Roofs Surfaced With Gravel, Slag or Similar Material.

The gravel- or slag-surfaced roof is at its best on the flatter inclines. It has been used successfully on inclines as steep as 6 in. to the foot, but should not be specified where the incline exceeds 2 in. to the foot, except in localities where the roofing contractors are generally familiar with applying the surface material on the incline in question, and with satisfactory results, or after definite arrangements have been made with the contractor who is to apply the roof.

Tarred felt and coal tar pitch in built-up roofs have demonstrated their value by long use. Poor roofs of this character, however, are not rare, but are directly traceable to one of three features: Either the material was not

coal tar pitch and coal tar saturated felt; or the materials were improperly applied; or there was not a sufficient quantity used.

The principal cause of failure of gravel roofs has been the use of an insufficient amount of pitch. The number of plies of felt count for but little except that as the number of plies increase the amount of pitch that it is practical to use also increases. This type of roofing is suitable for all classes of structures having roof inclines as mentioned above, and its economy is limited only by the permanency, the size and the location of the structure.

2. Built-up Roofs With Tile or Brick Set in Plastic Material or Cement Mortars.

The utility of a tile or brick surface depends largely on the purpose to which the roof is to be put other than in the keeping out of water, and, to a limited extent, on the character of the structure. The tile or brick surface increases the cost from four to five times, and protects the water-proofing course in such a manner that its life is practically the life of the structure, and they can not, therefore, be considered economical unless the roof surface is to be subjected to considerable traffic.

3. Built-up Roofs, Without Gravel, Slag or Tile Surface.

Where the roof incline is too steep to permit of gravel or slag, and the character of the structure requires a more permanent covering than will be provided by a single layer of prepared roofing, and the artistic features do not suggest overlapping tile or the slate, the desired result is best accomplished by using two or more thicknesses of prepared roofings. The surface layer may have a smooth or pebbled surface, but the under layer or layers must have a smooth surface. The common two- or three-ply tarred roofing or the rubber roofings are best suited for the under layer and the succeeding layer should be cemented to it with plastic pitch or asphalt.

4. Prepared Roofings, With Either Smooth or Sanded or Pebbled Surfaces.

These are, in theory, suited for all classes of structures, and all inclines, but they all have fundamental weaknesses which render them generally impracticable for the more or less permanent structures where the roof incline does not exceed 2 in. to the foot. The weaknesses referred to are as follows: Being laid in a single layer, a single defect will cause a leak; the narrow laps allow water to back underneath where wrinkles develop; exposed nails rust out, or when driven into cracks or unsound wood, work loose; the small amount of water-proofing, material, 40 to 70 lbs. per 100 sq. ft., as compared with a minimum of 150 in a built-up roof, and total absence of, or a limited use of, surfacing materials that are in no manner affected by the elements, and give protection to the water-proofing material.

A paragraph from the conclusions reported to the Maintenance of Way Association can well be quoted here: "Ready or prepared roofings are recommended for use on small, temporary, and other buildings, where the cost, considering maintenance of more expensive buildings, is not justified; for steep slopes, where a built-up coal tar roof can not be used, and for locations where the skilled labor necessary for a built-up roof is not available. The steeper the slope the greater their relative value and the wider their economical field. The heavier varieties are in general the more desirable, because of their chance for longer life and their greater fire-resisting value. In making selections, the reliability of the manufacturers, service tests, and the cost should be the governing factors."

5. Overlapping Tile, Slate or Cement Shingles.

These materials are suited only for inclines in excess of 6 in. to the foot. Tile is most expensive and is used only to produce desired artistic effects. Slate is also used for similar reasons, but is not as durable as tile, and here we might quote a paragraph from the report of the Maintenance of Way Association committee on roof coverings:

"Slate and tile of suitable quality, properly protected and fastened, can be recommended on roofs, with a pitch of 6 inches to the foot or over, when the expense is not the governing feature; and where they aid in producing the desired architectural effect, except where there is much chance of driving snow, when eight inches to the foot should be the flattest slope allowed. The use of cement shingles is largely in the experimental stage."

(*a*) Kind and Incline of Roof Decks:—The question of incline has been treated in preceding paragraphs. There are two general types of roof decks, combustible (wood) and incombustible (concrete or book tile), with wooden decks to be covered either with built-up or prepared roofing, the smoother the surface the better the results obtainable.

The roof boards should preferably be tongued and grooved, with close joints. Roughness or slight irregularities are not so objectionable where a built-up roof is to be used, because of the larger volume of material and greater elasticity in that type of roof, but the surface of the roof deck has an important bearing on the results, even of built-up roofs.

It is practicable to apply any of the built-up or prepared types of roofings to any fairly smooth wooden deck, except as the roof incline has a bearing on the built-up type. With decks of concrete or book tile, there must, on the steeper inclines, be provision for nailing, and this is usually provided for by wooden nailing strips when the deck itself can not be nailed into. The heavier the roof covering the more necessary is the nailing. With the built-up type, having a gravel or slag surface, nailing is necessary when the incline exceeds one inch to the foot, and such a surface over a built-up water-proofing course is impracticable where the incline exceeds six inches to the foot. Prepared roofings give relatively less satisfaction on incombustible roof decks of comparatively flat incline than on wooden decks.

(*b*) Size and Location of Building:—The smaller the building and the greater the distance from the base of operation, of the roofing contractor, the better is the relative value of the prepared roofings, as the same skilled labor is not necessary in their application and special tools or equipment are unnecessary. For instance, the extra cost per square for transportation of men and tools is a comparatively small item on large work, but on jobs of say five hundred to one thousand square feet, it would often be almost prohibitive.

(*c*) Adaptability for Proper Application by Railroad Men:—All of the prepared roofings can be applied by the labor usually available on railroads for such work. The built-up types, particularly those having a gravel, slag or tile surface, should be applied only by workmen experienced in the use of such materials, and such labor is not generally available outside of well-organized roofing crews.

(*d*) Necessity for Painting or Coating at Stated Intervals and Probability of this Being Done:—The tile surface provides a permanent covering, of approximately the same life as that of any structure, without maintenance of any kind. The gravel or slag surface, when properly applied, does not require attention or maintenance during practically the life of the roof. When the surface of pitch has practically all worn away, so that most of the gravel has become loose and leaks develop, the gravel should be removed and two plies of felt mopped on and then regraveled in the usual manner, at a considerable saving in cost over that of a new roof.

When leaks develop in a gravel surface prepared roof it is usually on account of the original coating wearing away to the extent that the bare felt is exposed. It then disintegrates rapidly and it is not considered practicable or economical to recoat such roofs.

Smooth-surface prepared roofings that require painting are objectionable, as it is often impracticable to do the work between the time when the need of it is noticed and the time when painting becomes useless.

A grit or pebble surface on prepared roofing permits of a larger amount of water-proofing material on the surface and to some extent protects it from erosion. It is rarely feasible to paint the entire surface of a prepared roofing with grit or pebble surface, although weak spots can be helped in this manner. With such roofing of good quality satisfactory results are usually

obtained, but there is no necessity for coating, and any general repairs to the entire surface is not economical.

(*e*) Fire Retardant Value:—The importance of the roof covering from the fire retardant point of view caused the National Board of Fire Underwriters to authorize a special investigation of the subject by the Underwriters' Laboratories, of Chicago, and a special appropriation was provided for the purpose. The complexity of the subject and the fact that the individuals or even associations can obtain little information of value from each of such tests as it is practicable for them to make at any expense that would seem warranted, is indicated by the fact that the laboratory investigations have cost upwards of ten thousand dollars, to date.

At present there are but three classes of roofings recognized by the National Board, namely: Incombustible, which includes tile, slate, brick and metal inflammable, including wooden shingles; while practically every other type of roofing from the best felt, pitch and gravel to the lightest prepared roofing is in the intermediate class. Early in the investigation, the fact was brought to light that there should be additional classes, and the classification adopted at the meeting of the National Fire Protection Association in New York, May last, provides for six classes.

The complete report is contained in the National Fire Protection Association Quarterly, issued from 87 Milk St., Boston, Mass. The following extracts from the report are of special interest in this connection, and show the thoroughness of the investigation.

EXTRACTS FROM REPORT OF COMMITTEE ON DEVICES AND MATERIALS ON PROPOSED STANDARD FOR ROOF COVERINGS AND TEST SPECIFICATIONS FOR THEIR CLASSIFICATION.

CLASS A.

To include roof coverings which afford a very high degree of fire protection to the roof structure; which are not readily flammable; which do not carry or communicate fire; which do not give off flammable vapors or gases in large volumes when exposed to high temperatures; which possess no flying brand hazard; which possess considerable blanketing influence upon fires within the building, and which are durable and require repairs or renewals only at very infrequent intervals.

Composition Roof Covering, with Brick Tile Surface, Composed of 1-inch Hard Burned Clay Tile, Laid in 1 Inch of Portland Cement Mortar.

Covering constructed in strict accordance with the specifications advocated by the committee on roofs and roofings, as published in the annual proceedings of 1908.

The covering consists of a layer of water-proofing, composed of five plies of tar-saturated felt embedded in coal tar pitch, and an incombustible wearing surface approximately 2 inches in thickness.

This roofing would come under Class A when applied to both combustible and non-combustible roof decks on inclines not exceeding 1 inch to the foot.

CLASS B.

To include roof coverings which afford a high degree of fire protection to the roof structure; which are not readily flammable; which do not carry or communicate fire; which possess little or no flying brand hazard; which possess considerable blanketing influence upon fires within the buildings; and which are durable and do not require frequent repairs or renewals.

Composition Roof Covering with Gravel Surface.

Constructed in accordance with specifications advocated by the above-mentioned committee.

The covering is composed of five plies of saturated felt, embedded and coated with coal tar pitch, into which the surfacing gravel is laid. This covering would probably come under Class B when applied either to fireproof or combustible roof decks, and where applied at inclines not exceeding 3 inches to the foot.

Note:—It should be explained that the specification for this particular type of roof covering nominates the best possible practice in the construction of a so-called tar and gravel roof. The specifications for the felt and pitch are rigid, and call for the use of a large quantity of pitch and gravel. Coverings which depart from this specification by reducing the quantity of gravel on the surface and the quality of felt and pitch, will undoubtedly take a lower classification. In fact, many of these coverings are liable to aid in the spread of fire over their surfaces, and after being subjected to the weather for several years will afford but little protection to the roof deck. The limitation relative to the height of incline is considered to be the maximum allowable height. It may develop from the field examination that it will be necessary to decrease this limit.

Tin Roofing—Flat Seams.

Covering constructed and materials used in strict accordance with the specifications advocated by the aforementioned committee.

This covering will probably fall in Class B for all inclines.

Note:—It should be particularly emphasized that the covering differs materially from tin roof coverings, as usually laid. The specifications call for the application of a 16-pound asbestos sheet, in addition to the ordinary roofing felt. This very materially adds to the fire resisting properties of the covering. The specifications also provide for a special form of seam, ⅝ inch wide, and a thorough means of nailing, which is very important in its influence on the life and behavior of the covering under fire exposure.

CLASS C.

To include roof coverings which afford a moderate degree of fire protection to the roof structure; which are not readily flammable; which do not carry or comunicate fire; which possess little or no flying brand hazard; which possess moderate blanketing influence to fires within the building; and which are durable, but which require renewals at fairly infrequent intervals.

Prepared Roofing—Asbestos Felt.

This covering is prepared ready to lay and can be applied to either combustible or non-combustible decks. It will fall in Class B, where applied to incombustible roof decks, and possibly in Class C when applied to combustible decks.

It is claimed that this covering is suitable for application to practically any incline, and if field experience proves this to be the case, it would probably take the indicated classification for all inclines.

Note:—As a word of explanation, it should be said that there are a considerable number of prepared asbestos roofings, and also so-called built-up asbestos roofings, on the market. The classification given here covers only a specific type of the prepared roofing, which is made up of plies of asbestos felt paper cemented together with an asphaltic cement. It must not be understood that the classification indicated would cover other asbestos roofings.

CLASS D.

To include roof coverings which afford a slight degree of fire protection to the roof structure; which are not readily flammable; which do not readily carry or communicate fire; which possess a moderate flying brand hazard;

which possess little blanketing influence upon fires within the building, and which require repairs or renewals at fairly frequent intervals.

Natural Slate—Laid Shingle Fashion.

Covering composed of slate 9x18 inches, laid 7½ inches to the weather over sheathing paper, and held by two nails. This covering would probably fall in Class D, where applied to inclines not less than 6 inches to the foot.

Note:—The quality of slate varies so widely that it would not be fair to say that all slate is entitled to this rating. It is probable that some types of slate might be entitled to a classification as high as Class C.

CLASS E.

To include roof coverings which afford little or no fire protection to the roof structure; which are not readily flammable; which do not readily carry or communicate fire; which possess a moderate flying brand hazard; which possess little or no blanketing influence upon fires within buildings and which may require repairs or renewals at fairly frequent intervals.

Prepared Wool Felt—Stone Surface.

Roof coverings of this general class, made of the best quality of materials and thoroughly covered with a layer of incombustible material, should qualify for Class D.

It is at present known that many of the so-called stone surface prepared roofings will not classify even as high as Class E. On the other hand, it is felt that there are many coverings which will take the classification indicated.

CLASS F.

To include roof coverings which afford little or no fire protection to the roof structure; which are readily flammable; which will rapidly carry and communicate fire; which possess more or less severe brand hazard; which possess little or no blanketing influence to fires within the building; and which may require repairs or renewals at fairly frequent intervals.

Prepared Smooth Surface Roofings.

It is believed that many of the prepared smooth surface roof coverings will qualify for Class E, and possibly some of them may possess sufficient value to classify under D. It is known, however, that some of them will fall in Class F.

The committee particularly wishes to emphasize the hazard attached to the use of wooden shingles. Wooden shingle roofs are a menace to property, and have repeatedly demonstrated their hazardous nature as conflagration breeders. Their use is prohibited by law in many localities. It should also be noted that, as compared with roof coverings possessing fire retardant properties, wooden shingle roofs now require repairs and renewals at fairly frequent intervals.

GUARANTEES.

Guarantees have become more of a factor in roofing than in any other work connected with building construction and are frequently put in the foreground, so that the real point at issue, the merit of the roofing, will be overlooked. They should, therefore, be subjected to the closest scrutiny. Very naturally guarantees for five years or ten years will appear in the light of a safeguard, but they are not given because of the sublime faith the guarantor has in his roofing or because of any generous impulse on his part to protect the buyer, but for one purpose only—to sell the roofings. For the purpose of considering their value, they may be divided into three classes:

First: Where the guarantor is responsible, and gives the guarantee in good faith. In such cases the buyer has the assurance that the roof will be repaired if it leaks, but there is not any protection against damage, as a guarantee against damage would be a greater liability than any solvent contractor would assume, even with the best of roofs. No matter how often leaks occur, all the owner can require is that repairs be made with reasonable promptness, and, as frequently happens, it is better to buy a new roof than to stand the loss and inconvenience caused by leaks.

Second: When the guarantor is responsible, but purposely words the guarantee to mislead, and avoid legal responsibility. This class is the most misleading and causes the greatest loss. It embraces the "painting every so often" clause, usually calling for material which the owner must buy and apply at certain specified times. One day over, and the guarantee is in doubt. This means a division of responsibility, and there are literally dozens of excuses why the manufacturer is not to blame; and then include many that are fair, as roofing is frequently used on a roof incline for which it is entirely unsuited.

Third: Where the guarantor does not remain in business or remain solvent for the term of guarantee. A surprisingly large percentage of firms remain in business less than five years, to say nothing of ten years, and this is no more true of any class than of roofing contractors.

Tile, slate, copper and shingle roofs are rarely guaranteed for more than one year, if at all, so they need not be considered, but it is the two classes, "prepared roofing" and "built-up gravel or slag roofs" that have been and are most affected by long time guarantees.

In buying prepared roofing the character of the building, the incline of the roof, the chances of the roof being recoated when needed (if roofing is used that requires such care), the length of service the roof is expected to give, the experience of others with the same material used under the same conditions for as long a time as it is claimed it will last (printed testimonials should not be accepted without careful investigation), and the reputation of the manufacturer for fair dealing; that is, his practice of making good without written guarantees is a factor of far greater importance than any guarantees. When, with built-up gravel or slag roofs it was the general custom to consider the quality of material, amount of material (that is, the number of plies and weight of felt, and pounds of pitch), knowledge regarding the use of the materials and records of roofs in service, it was usual to have gravel roofs last longer than they do today; but since the ten-year guarantee was made the basis for price, and contracts awarded to the lowest bidder, most of the responsible roofing contractors have had no option except to figure on a ten-year roof, and if the contract was awarded that is all they could give, as it was all they were paid for or agreed to give. Generally, a roof which requires no repairs for ten years will give service for a much longer time, but naturally roofs that require repairs during the term of guarantee are of little value at its expiration.

In conclusion, our recommendations are that all structures with a roof incline of less than two inches to the foot be covered with a built-up gravel or slag roof, constructed under a specification, definite especially as regards amount of materials, and that there be competent inspectors to see that the specifications are fulfilled; that prepared roofings be used on temporary structures and those of minor importance and all steeper inclines, except where architectural features demand tile or slate, and that preference be given to the smooth surfaced roofings where there is a certainty of recoating when needed, and to grit or pebble surfaced roofings when such care will not be necessary; that prepared roofings be applied by railroad men, that where painting or coating is necessary there be a system that will insure a thorough inspection and report on the condition of the roof at least once in six months and that from the fire retardant point of view, roofings be selected in the following order:

Tile, gravel or crushed stone or slag, metal, asbestos, slate, pebble surface prepared; grit surface prepared; smooth surface prepared.

T. J. Fullem,
G. W. Andrews,
Committee.

DISCUSSION.

The President:—The assistant secretary will now read the report of the committee on subject No. 10, Roofs and Roof Coverings.

(Mr. Jutton read the report.)

The President:—Before opening the discussion, I want to say that we have with us tonight a gentleman who has given the matter of roofs and roof coverings considerable study in connection with his investigations for the American Railway Engineering Association, and he has promised to give us a talk on the same subject. I want to introduce to you Mr. Maurice Coburn, principal assistant engineer of the Vandalia R. R.

Mr. Coburn:—I did not understand that I was going to open this discussion. We have had a very interesting time, investigating the roofing question. The subject committee of which I was formerly chairman, took it up because the choice was left to me and I selected roofing because I knew absolutely nothing about it and wanted to learn something.

The main thing we have tried to do has been to get some knowledge of the bituminous roofing materials and their relative qualities. The industry is a large and growing one, but it is a new one, and almost all of the definite and accurate information has been in the hands of the manufacturers, so that when we tried to get some idea of the comparative value of these materials we found it was a difficult matter. Most of you know how we have all suffered from the roofing salesman who has been sent out without any information which he could give us which was of value. He did not know himself, and we can not blame him for not telling us anything. The manufactureres themselves often did not know so very much about it, and what they did know they kept to themselves. We have all been told that these various roofings were made of a wonderful secret compound which they have developed after many years of experience and which it would not do for us to know anything about.

In the built-up roofings, most of us think that we have the best type of a bituminous roof, because there we can get all the material we want. With a ready roofing, the amount that can be put into a roll is very much limited.

For the built-up roofings the question arises as to a choice be-

tween a coal tar roof and an asphalt roof. Our committee last year recommended a built-up coal tar roof, for several reasons. The asphalt roof has some very decided advantages. The coal tar melts readily and gets brittle very easily. In the summer time it is soft and runs, and in the winter time it is brittle and cracks; but it is easy of application and it is cheaper than the asphalt material, both as to the first cost of the material and the cost of application. We can control the flowing of the pitch and we can lay it so it gives good results. We all know that we have had many good roofs which have lasted as long as anybody could expect a roof to last, and often as long as we want it to last.

The asphalt material is an uncertain quantity; it is a mixture of several different materials. In buying it one must depend entirely on the word of the man selling it, and in laying it requires more skill in its application than a coal tar roof.

I think that almost everybody agrees that we get more for our money out of the coal tar roof. When the asphalt man comes in to see you he will tell you, nine times out of ten, that the coal tar we get nowadays is not as good as it used to be. We do not think that is so. There have been a great many failures of coal tar roofs during the past few years, but notwithstanding the fact that the coal tar industry is largely in the hands of a single concern, we think we are able to get good roofing material and we feel that this concern is trying to improve the quality of their material. When it comes to asphalt, it is made by a great many different people and it is a great deal more difficult to get accurate results.

The water-gas tar question is by no means a closed one, but I believe that practically all agree that the small percentage of free carbon contained makes its pitch a poor top coating, and the most practical roofing men seem to agree that its products, used either as saturants or coatings, are not as stable as those made from coal tar.

When it comes to ready roofing, coal tar is not at all a fit material, in our opinion. Coal tar is valuable only when it is in a thick layer. If we take a piece of coal tar felt and put it up with a piece of asphalt felt, the coal tar felt will get brittle much quicker than the asphalt felt. Almost always, when the coal tar weathers there is a little hard scale of free carbon or other hard material on the surface, which, in a measure, protects the rest of it. The inner parts stay soft and keep their life, if it is good material. One of the troubles with coal tar roofs has been that so many have been built out of poor coal tar or built poorly.

In the ready roofings, there is, in our opinion, almost no virtue

in a single asphalt fluxed with an oil. One must get a mixture of several different asphalts to obtain a satisfactory substance, and when they come around and tell you that they have got a Gilsonite roof fluxed with oil or a Trinidad roof fluxed with oil, it is surely a poor roof, if they are telling you the truth. The best results are obtained by mixing three or four different things. Some of our good friends think that Trinidad is good for roofing and some think it is very questionable whether it is essential to good roofing. It has been much advertised. Gilsonite, the western asphalt, has certain virtues, but mixed with oil alone it is a poor stuff, because the oil dries out. The California oil residuals have certain virtues and petroleum residual oils, blown or treated with air have certain other valuable qualities. They are not easily affected by changes in temperature and the atmosphere does not seem to have much action on them. Elaterite, a western asphalt which, in some ways, resembles Gilsonite, furnishes a product which is used in some of the best ready roofings and sells for a high price; and by mixing some of these different products and fluxing with some oil, we can get a very fine mixture; but when it comes to using it and having it applied by unskilled people, owing to the heat necessary and the ease with which it cools, we are not sure of getting such good results especially in cold weather on a built-up roof. But, for a ready roofing, something of that sort seems to be what gives good results. Some of the mixtures are fine and some poor. We cannot tell by any analysis or any knowledge of the material beforehand unless we know how it is mixed, and we do not know how that is done; only the skilled man knows that.

The quality of the felt does not make so very much difference. We are told about all-wool felt, but we feel like the farmer who went to the circus and saw the giraffe for the first time—"There ain't no such animal."

Every few weeks our committee learns something new, and we change our opinion to some extent. I learned something last week which materially affected some things I thought I knew very thoroughly and I have now been on the subject two years and a half. You should take all I tell you with a grain of salt, and if you have any information with which to correct us in our reports, we would like to have it. (Applause.)

The President:—We all feel very grateful to Mr. Coburn for the talk that he has given us and I feel that he gave us a great deal of information on the subject. We will now discuss the report as it has been read. We would like to hear the members express them-

selves quite freely on the subject as it is a very important one. Mr. Fullem is not here, and I will therefore call upon Mr. Andrews who is the next member on the committee. Will you kindly give us your views, Mr. Andrews?

Mr. G. W. Andrews:—I have very little to say in addition to what is incorporated in the report. It is true that this committee, I think, labored under the same difficulties that the committee of the American Railway Engineering Association labored under. I will say that, because I was on the same committee with Mr. Coburn and I can vouch for the truth of the statements that he has made relative to the difficulty that we have experienced in getting information from the sales agents and from the manufacturers of the various kinds of ready prepared roofing. I will say this, though, in justice to the sales agents, that I believe they have always given me all the information that they had. As a rule, however, their information was based simply upon what they had been told by the manufacturers, concerning the quality of material, and, of course, they were trying to sell as much as possible. I always like to see them come into my office, because when they go out they almost invariably say that, while they have tried to sell material, they have not been able to get me to say anything to them. The information given in the report states the views of the committee, I think, very clearly, and in the absence of Mr. Fullem I would be very glad, if possible, to explain any discrepancies that some of our members may feel are incorporated in the report.

A Member:—I would like to ask Mr. Andrews why the committee considers tiled roofing more durable than slate.

Mr. Andrews:—I don't know, Mr. President; I cannot recall whether the report states that or not. If it does, it does not fully express my views. Personally, I think that slate is preferable to tile.

Mr. A. S. Markley:—Can I get the sense of the report in reference to book tile? As I understood the reading of it, it would be necessary to put on wood to nail the felt to. Perhaps I don't understand it thoroughly. That is different from the way we have been using it.

(Mr. Andrews re-read a portion of the report.)

Mr. A. S. Markley:—In putting on roofing of book tile, we have always applied the tar and then laid the felt in it. I do not believe that it is hardly necessary, in a case of that kind, to use nailing strips. Tar, properly tempered, will hold, on a roof quite steep. The roof I refer to was put on in 1904. It has a pitch of one and a half inches to the foot, and since then there have been no repairs

and no leaks whatever. We used Barrett's preparations in the make-up of the tar. Furthermore, in reference to built-up roofs—in 1884 we put a roof on our freight house in Chicago at 12th Street, with our own bridge carpenters, and, of course, we were liberal with the tar, realizing that it was an important roof and we wanted to keep all the dampness or water out, that was possible. We have recoated that roof but once since 1884, and that is the reason why we favor a built-up roof in almost every case. Wherever a building can be built with a view of using that character of roof, it should be done. I would like to hear from some other member. Mr. Horning, you have quite a lot of information and experience about roofs of all kinds.

Mr. Horning:—We have roofs of nearly all descriptions. In the question of a roof however the particular design of a building usually governs the particular kind of roof to apply. There can be very little question about the reasons for applying a tile roof equally so with slate. The design of a building, in nearly every case, will distinguish plainly between the two. We use tile for some stations and have received very good results. Also we use slate for a portion of our more expensive buildings with reasonable success. The prepared roofing that we used has given moderate satisfaction. We use it on small buildings especially and on buildings in out of the way places where other roofs cannot readily be had, but in no case do we use them on passenger stations where appearances are to be considered.

The question of roofs is a live subject and it would seem to me at this time that the problems relating to it have not been exactly solved. It is a question that should be continued next year because nearly every member here has, no doubt, had more or less trouble.

Mr. C. J. Scribner:—The roofing men seem fairly well represented in the lobby and I presume we could get some information on this subject from them. I would suggest that we invite them in.

The President:—I do not suppose there would be any particular objection, with the understanding that no particular brand of roofing should be advocated. In other words, it should not be made an advertising scheme. We would be very glad to have the roofing men state their views of the matter, without advocating any particular brand.

Mr. H. A. Wardell:—The question has been brought up as to the relative merits of asphalt and coal tar pitch. Before going into the subject I wish to refer to Mr. Coburn's statement relative to the roofing salesmen being something of a nuisance. I believe that, to

a certain extent, he is correct, but we have all first to learn, and every young man who takes a position as a roofing salesman goes out with the information that is given him by his superior officers. He may get it all or he may get a smattering of it, but he does his best, and in doing it he is trying to make an honest living. Sometimes, like a fly, he tracks good things into the offices of you gentlemen, as well as being a "nuisance" by tracking in things which are not interesting.

Mr. Coburn very correctly states that coal tar pitch makes an excellent roof. He who says it does not, does not know the roofing business. Experts in the roofing line state, however, that it is good only on flat surfaces or those with a pitch not in excess of two inches to the foot. Expert tar people also very strongly advise the use of "enough" pitch, and claim that failure is due to improper application and insufficient material. They also advise very strongly against "improper materials." Those who have to do with manufacturing pitch from water gas claim it to be equal to pitch made when making gas or coke from bituminous coal. Those who control the pitch of this country, made from bituminous coal, say pitch resulting from the manufacturing of water gas is not good. Who is right? And if this is a fact, is it not a fact that it is just as difficult to get good tar pitch as it is to get good asphalt? I do not pretend to say gas pitch is no good. If I did you would all know that I do not know what I am talking about. But I do say that pitch, both practically and theoretically, is not as good as good asphalt, and I think I can prove it. Furthermore, I claim it is just as difficult to get good tar pitch as good asphalt. The asphalt industry is in the hands of few people and the coal tar industry is in the hands of fewer people. Nevertheless, both good asphalt and good coal tar pitch may be had; it depends entirely upon the purchaser.

Mr. Coburn has said he believes that perhaps water gas tar is a little more worthy of consideration than a year ago. Is it really any different than it ever was—and what is coal tar and what is water gas tar? Coal tar is the result of breaking down bituminous coal in either a gas retort or a new process coke oven. Water gas tar results from making gas by the water process. Both contain valuable constituent parts, especially the tar made from bituminous coal—parts worth double the price of pitch—and there is a shortage of creosote oil, one of the parts derived from the separation of the bituminous tar, the so-called best tar. There are, however, certain lighter oils that are not so valuable and they come off before the creosote oils, and are used to make what is known as "cut back"

pitch; and "cut back" pitch is very difficult to distinguish outside of the laboratory, from straight run pitch. Bituminous coal tar pitch also contains 20 to 30 per cent of free carbon or soot, an inert material, which, according to coal tar people, is necessary "to give it body."

I don't want to throw any bricks at coal tar, because it has given excellent service, and a good coal tar roof can be constructed today with honest workmen and honest materials, but I want to say that it is just as difficult to get honest workmen and honest materials with coal tar pitch as with asphalt, Mr. Coburn to the contrary notwithstanding.

Asphalt comes from many parts of the world and nearly every asphalt has different characteristics; Grahamite, from Indian Territory, West Virginia, Cuba, Colorado and other small deposits; Gilsonite from Utah, and asphalt, resembling Gilsonite very closely, from Cuba and Egypt; lake asphalt, from Trinidad, Bermudez and Maracaibo and many others. Elaterite, referred to in the report as being an asphalt, is not asphalt in the true sense of the word and is not generally used for roofing. It is a hybrid—a peculiar material not readily soluble in the usual solvents and can not be used in connection with flux oils by heating. It is broken down in a retort by the exclusion of oxygen. It has valuable characteristics after it is broken down in connection with other asphalts.

Trinidad Lake asphalt comes from Trinidad, B. W. I., and has probably been used to a greater extent for street paving and other purposes than any other asphalt. Why? Because it has universally proved to be the best asphalt ever discovered. Asphalt is better than coal tar, because it is longer lived; because it contains the necessary non-fugitive oils to keep it alive, which is not the case with coal tar. To prove this, let us consider a street pavement. A pavement is composed of 90 per cent mineral, in the shape of silicate (sand, if you please) and limestone or other mineral dust, and these granules of sand and dust are cemented together with asphalt; and just so long as the asphalt has the ability to cement those particles of mineral together, just so long will the street live and not a day afterward. This, therefore, proves that asphalt, even Gilsonite, has cementing characteristics for a greater length of time than coal tar pitch. Primarily, coal tar pitch is just as good as asphalt, but coal tar or coal tar pitch do not contain the necessary non-volatile everlasting oils that are necessary for a durable lasting waterproof cement, and asphalt does. To prove this coal tar roofing pitch and Trinidad Lake asphalt roofing cement can be submitted to the usual

laboratory test for stability. The test is to subject the materials to 325° F. for seven hours. Asphalt cement will lose less than 8 per cent, the residue being soft and plastic, while coal tar pitch will lose 15 to 20 per cent, the residue being very hard, glass-like and lifeless.

What does this all prove? A roof depends on the cement holding the plies of felt securely together, indefinitely, as the cement holds together the sand in an asphalt street, and the laboratory test shows conclusively that the necessary oils to keep it alive and plastic and able to maintain the cement in action are very much more stable in asphalt than in coal tar pitch.

There are concerns manufacturing asphalt in the United States with good reputation, people who brand their materials; people who have the ability to properly combine asphalt mixtures; so you can get asphalt roofing cement which is and will remain plastic practically forever. Perhaps you might think that this statement cannot be borne out by facts, nevertheless there is a little story that makes everybody smile, but it is a true one. It is a well-known fact that mummies have been disinterred, showing that the body had been wrapped in a cloth saturated with asphalt, where the asphalt has been found to still have life. I know where coal tar pitch has been brought out of the ground in New York City, full of life after many years, thus showing that both of these materials will live, if they are not subjected to the influences of sunlight and the atmosphere, indefinitely, but in a street or on a roof it is quite another matter. I make this statement so as to be absolutely fair, but I do not believe it can be shown that coal tar pitch is better than asphalt, or that there is any more difficulty in obtaining good asphalt than good pitch. Coal tar pitch, it is admitted, depends for its life on being coated or covered, if you please, with some material such as slag or gravel, which has the effect of making it immune to the deadly action of the rays of the sun. Asphalt is just as susceptible to these influences as coal tar pitch. Thus an asphalt-coated roof needs slag or gravel or some other covering just as much as coal tar pitch, but coal tar pitch, as before explained, will dry out and disintegrate much faster than asphalt.

Coal tar pitch has one characteristic that asphalt has not. It contains a small amount of creosote, which is a fungicide and which prevents the wool felt from rotting. I admit that wool felt saturated and not coated with asphalt will rot if kept wet, but it will not dry out and be as lifeless as a chip. I claim that several layers of asphalt felt properly protected from underneath moisture, will give a good and lasting account of itself.

There are good and reliable manufacturers of asphalt felts and asphalt cement, who have been making these materials for twenty-five years. They use Trinidad asphalt and they stand by it today and have a good right to do so, because the materials are good. Mr. Coburn, or any of you gentlemen, can get a certain brand of asphalt and know that it will be good stuff, and there are a number of other brands on the market just as good.

If you gentlemen will look into this asphalt question, you will find that it is being used by high-class, reputable concerns; concerns that are honest in their endeavor to turn out a roofing which, perhaps, is not perfect, but is at least sincerely made; and I claim to represent one of these concerns, but I am not here to advertise any brand. I want to say that if asphalt will live for twenty-five years in a street, holding together a mineral aggregate of sand, (Theressa Ave., in this city, for instance), why then is it not the best cement to hold together the waterproofing on a roof? On a roof it does not have to contend with conditions which exist in a street; such as attrition, acids and innumerable other things. Therefore I claim again that it has much greater life and endurance than coal tar pitch. If it was not better than coal tar pitch why is the latter not used for paving, and by the manufacturers of the so-called rubber roofing, including the largest coal tar people who make the rubber type of roofing? You must admit that in this class of roofing material no very great quantity of asphalt is used per square foot, as compared with coal tar built-up roof. Why should we use 7,500 tons of asphalt per year in the manufacture of roofing materials if we did not know which is best. We do not mine asphalt—we refine it. We do not produce coal tar pitch. We have absolutely no interest in either beyond the fact of getting the best possible material. Why, then, should we spend $15 more per ton for asphalt if coal tar pitch is as good? Our reputation and our success is dependent upon the longevity of our roofing and its ability to keep out water.

I might dwell upon the manufacture of felts, on the residual asphalts that are produced by distilling Texas and California oil, and on many interesting phenomena occurring in manipulating asphalts in coal tar pitches. I could tell you of the asbestos fibre and why it makes a wonderful fireproof, weatherproof, sunproof, waterproof roofing fabric. How it makes capillary attraction (the death-dealing agent of all volatile substances) impossible, and tell you of the really great progress that has been made with roofing materials, but I am only asked to discuss the question of merit be-

tween asphalt and tar pitch. I am obliged to you for your attention.

Mr. O'Neill:—I have listened to a great many talks from agents who represent the roof manufacturers, and this is the first agent who ever left me after a good talk without offering me a cigar. Now the gentleman has given us a good talk. I want to say that he seems to be better posted on the goods that he is handling than any man that I have ever talked with on the question, who represented roofing, and I was pleased to listen to his talk, but was a little sorry, of course, that he didn't hand out the cigar.

Now I want to touch on the question of the wooden cleats on book tile. I don't just understand, myself, how they could be put on, how they could be fastened there without being rather expensive. Of course book tile is laid on angle plates, and they could be drilled and the wooden strips fastened, but it would be an expensive method. Six years ago this summer, I built up a roof of book tile with a pitch of four inches to the foot, and it has never given any trouble. It is apparently in good condition today, and all that fastens it in the book tile is a good coating of hot coal tar pitch and the paper rolled into it as a beginning, each successive layer rolled in coal tar pitch and applied to the next layer below. I can not see the necessity of any wooden strips or nailing in order to fasten a built-up roof on book tile.

Mr. J. H. Markley:—I do not want to be accused of being ungrateful to the committee, but in our practice of recoating built-up roofs, we, in all cases, take off all the gravel we can, recoat it and put the gravel on again. I have never known of any paper or felt put on the roof in the recoating process. One cannot get all the gravel off, of course, and there are pebbles that stick up so that it would be difficult to make the felt adhere unless enough tar was used to bring it up above all the pebbles so as to make a smooth surface. We have a roof that I spoke of awhile ago, on which we used that method. We swept all the dirt off and took off all the loose gravel. What stuck to the roof we left on. I notice that the report says to put the paper on over the gravel in recoating.

Mr. L. P. Sibley:—I am perhaps more interested in coal tar products than asphalt, and I have a few words to say in reply to the statement that Mr. Wardell made. Before doing so, I would like to reply to the last speaker, in regard to the resurfacing of a gravel roof; that is, by scraping off the gravel and putting on additional plies of felt. That is practical only when the pitch on the surface has largely worn off and the gravel become loose. Most of

the gravel can then be swept off and what is still imbedded in the pitch can be scratched off with scratching bars, so as to provide a surface sufficiently smooth to lay additional plies of felt; and while that is not economy ordinarily, there are frequently buildings that for various reasons may not warrant the cost of a new roof, but would warrant the cost of two plies of felt and regraveling.

In regard to the placing of nailing strips in book tile, I agree with the criticism that it is hardly practicable. It is, however, practicable to bed the nailing strips in concrete as the concrete is being made. It is a fact that the built-up type of roofing is applied on inclines exceeding an inch to the foot without nailing, and applied successfully, but the factor of safety is not large, and there have been numerous instances where such roofs have slid or slipped for lack of proper nailing. I think the general opinion is that where the incline exceeds one inch to the foot, nailing of some kind is desirable.

As regards the illustration made use of by Mr. Wardell, that because asphalt is best for paving it must be best for roofing: The fact has been brought out that paving, 90 per cent of the pavement is a mineral, that is, silica or sand, while only approximately 10 per cent is a bituminous material or asphalt. It is an acknowledged fact that asphalt is less easily affected by heat and cold than coal tar pitch, and a pavement that will not become soft in summer or brittle in winter, is a very necessary factor. Pavements are all subjected to considerable traffic that keeps them compacted during warm weather, and I think it is quite generally recognized that with a street having a fair traffic the pavement on it will last much better and is far less liable to crack than on a street with comparatively little traffic. A roof does not have such traffic, and on a roof the asphalt is used clear, not mixed with 90 per cent of sand. A roof must resist water, not traffic.

The statement has been made that the life of coal tar pitch is dependent on the oil in that pitch, and that it can be easily shown by accelerated tests (accelerated test, not field experience tests), with a temperature of 325 degrees, that the life of the coal tar material is much less than that of asphalt. There is a very good reason why those tests show a higher evaporative loss on coal tar materials than on asphalt materials, because the coal tar materials, being more easily affected by heat, become more liquid at that temperature than the asphalt materials do.

Nothing has been said about the oils that are required for the fluxing of asphalt. The Trinidad asphalt mentioned, that is more

successfully used in paving and more generally used in roofing than any other kind, requires upwards of 30 per cent of flux of some kind before it can be used even as a roofing cement, and when one talks of saturating felt with pure Trinidad asphalt, it is asphalt only in name, because Trinidad asphalt is naturally a solid. It requires upwards of 75 per cent of oil flux before natural asphalt can be used to saturate felt, but it is still called asphalt, even with 75 per cent flux; and as the asphalt used in preserving mummies has remained uninjured for centuries, asphalt is, of course, good for roofing. Coal tar pitch was not used to preserve mummies, but it is the waterproofing agent in more than 95 per cent of all the gravel or slag roofs in America, even though asphalt, with all its wonderful properties and unlimited supply, has been actively promoted for more than thirty-five years. Good roofs have been constructed with asphalt, the same as with coal tar pitch, but it is coal tar pitch that gives the best value. Results prove it and the figures show that the general public learned this fact long ago.

As your report has stated, the principal reason for the poor so-called tar-and-gravel roofs, is the use of an insufficient amount of material, and as the report of the American Railway Engineering Association committee on roofing, of which Mr. Coburn was chairman, stated, the good results from gravel roofing were undoubtedly due to the fact that a large volume of material was used in such roofs. The poor roofs have had perhaps the same number of plies of felt, but the number of plies of felt has very little relation to the value of a roof, except as the number of plies increases, the amount of pitch that it is practical to use also increases, and if one is to have good value for the felt used, there should be a complete mopping of pitch with each ply of felt, beginning with the second ply. When the roof deck is of boards, it is usually considered necessary that there should be two plies of felt under the first mopping of pitch, but with a concrete roof deck each ply of felt should be mopped solid.

The use of gravel or slag on the surface of the roof protects the waterproofing material from the direct rays of the sun and from the erosion or the wearing from the rain that flows over the roof, and it further permits the use of more than a paint coat on the surface, because the gravel or slag tends to hold the pitch in place. The same is true whether the pitch is a coal tar pitch or an asphalt pitch.

Mr. Coburn:—Regarding the statements that have been made, particularly by Mr. Wardell, I think I agree with more of them than might at first appear. Our committee, I believe, has fully agreed

that you can get just as good, if not a better roof from an asphalt pitch as from a coal tar pitch, but we do not think that in the long run, dollar for dollar, one can get as much value at the present time, from buying built-up asphalt roofs, as he can from coal tar roofs. I ought to say, also, that the roofing people are coming more and more to help us. I think that we are going to get together better, to understand each other better and understand the materials better. I also wish to say, that in my opinion, some of the things Mr. Wardell said in comparing the different materials are very misleading.

S. J. Waterman:—The old saw of "there's nothing like leather" in railroad parlance and practice, should be transformed into "there's nothing like metal." No other material so fully meets the requirements of railroad construction in its easy adaptibility, in its great variety of forms, to all the demands of buildings, bridges, etc., in its reasonable price, both for material and application, in the low cost of repair and replacement, and its durability in service. This is especially true of metal in the form of sheets for roofing purposes, and the protection of wooden bridges and trestles against fire and weather. In the most popular form of corrugated sheets it can be used for roofs on a metal frame or simple structure of wood sheeting and purlins, eliminating sheeting boards, which most forms of roofing demand; thus both reducing expense and rendering the structure proof against fire without or within. Where conditions make other forms preferable it can be furnished in plain sheets, black, painted or galvanized, "roll and cap roofing," "V crimp" metal shingles, "standing seam," etc. In these varied shapes its use is familiar to you all, and I think I am safe in saying that no other roofing has had so large a demand and made so honorable a record in your service. Many of you have personal knowledge of old metal roofs which, after a life of twenty years and upwards, have been removed because of alterations, improvements or like causes and found perfectly sound.

I read in a recent article in the Engineering News of timbers in trestles erected in 1879 and protected by galvanized iron sheets that were examined and found sound, only rotting where bolt holes, etc., had permitted the weather to affect the parts immediately exposed thereby. The sheets not only protected the bridge deck against fire, but preserved it better than ballast would have done.

Since the turn of the century, with the general adoption of steel sheets in place of iron (due both to lower cost and the better working qualities of the former), it has been found that metal does not

give as satisfactory service as of old, and I believe your organization is on record as discouraging the use of steel sheets for the above named purposes.

No one was more keenly alive to this vital defect in their product than some of the rolling mills themselves, and various methods were tried to improve roofing products, mainly along the line of coating sheets with different substances to prevent corrosion. But one mill, at least, recognized that the trouble lay deeper than the surface and has met it by a most thorough and scientific process of fabricating the metal itself so as to produce a pure iron sheet, anti-corrosive, and free from those elements which, in steel sheets, are the points of attack for moisture, sulphur and other gases. This article has stood up under the most drastic acid, salt and alkali tests, but more than all in the test of actual service, during the past five years, has it justified the claim that it has the staying qualities of the old Juniata iron sheets, no longer made. Its cost is much less than the price Juniata iron sheets used to bring, and little more than that of steel. Its long life in service renders it a most economical material, far outlasting steel sheets. While the greatest emphasis is placed on the base sheet, which determines the final durability of the roof or deck protection, the added safeguard of any desired coating of paint or galvanizing is furnished, when required, and it is marketed in all forms of roofing, as well as in the plain sheets. In no other field has this metal created such interest by good record as with the railroads, a considerable number of whom are specifying it largely in place of steel sheets for buildings, bridges, culverts and flumes.

Mr. Robinson:—The opinion was expressed here that composition roofing should not be used, or was not adapted for use, on passenger stations. The train shed of our old Wells St. terminal, in Chicago, was covered seven years ago with that style of roofing, and, while it was subjected to about as hard usage as any roof, it gave most excellent service. When that shed was torn down this year some of the composition roofing was removed elsewhere and applied to another building in order to see how much longer it would last. The structure from which it was removed had a pitch of only about two inches per foot.

Within the past year we had a new station built by contract with a roof made up of coal tar pitch and gravel, from which have resulted several claims for damages on account of the pitch dripping over the edges and soiling ladies' clothing.

We also had a building at the Chicago shops which had a coal tar pitch and gravel roof, the building having been used as a store-

house for patterns. Some of the boards shrunk, the felt opened up and some of the pitch ran through and damaged a lot of our valuable patterns. Other buildings were built near by in 1892 to 1894 which were covered with similar materials, and they gave most excellent satisfaction; these buildings have had the roofs repaired but once in the meantime.

Then, again, we put up a building about ten years ago, about 200 feet by 600 feet, which was covered with composition roofing, and that roof is still in excellent shape; hence it may be said that good roofs may be made of either of these two classes of roofing if they are composed of good material and properly applied.

Some of our shop buildings at Chicago, which were built in 1871, were furnished with slate roofs, and those which had the slate fastened with copper nails are yet in good condition. Where galvanized nails were used we have had to repair them.

On some of our suburban stations, constructed in 1896, we used tile. One of these we have had to renew this year. This tile was supposed to be practically indestructible, but it seemed to granulate and go all to pieces, quite suddenly. We could notice the formation of little yellow or reddish spots, and soon after that it would disintegrate. The concern whose tile was used renewed the roof at its own expense. Some of the other tile roofs, put on at the same time and by the same firm, are still in use and appear to be in first-class condition.

Mr. Sibley:—About the roofs dripping:—This work was in Chicago, and I think it is quite a common practice with contractors to mix tar with their pitch. That probably accounts for the tar dripping from the eaves or working through the roof. The terms pitch and tar are not always understood, but at normal temperatures pitch is a solid and tar is a liquid. It is not practicable to use a coal tar pitch with a melting point under 135 or 140, and that is not sticky enough to damage the costumes of the ladies even in the hottest of weather. If it was soft or tarry enough to do that, it must have been caused by mixing tar with the pitch, which is done for the sake of economy, because the material spreads easier and goes further.

Mr. O'Neill:—I think that under certain circumstances there will be considerable drippage, even where pure commercial coal tar pitch is used. I put a roof over a boiler room on book tile, the one I spoke of before, and had considerable trouble with the seepage through the book tile and the lath which were put on to fasten the first layer of paper to. Of course, the conditions were not very

good; it was right over the boiler room and it got pretty hot up there, but it took almost a year before it got through dripping, and it was a pure commercial coal tar pitch.

The President:—I think this report is a very valuable one and the discussions which have been brought out, both by our own members and Mr. Coburn and the representatives of the roofing fraternity have given us considerable food for reflection. We all agree that the solution of the problem is simply a matter of continuous investigation and study. I believe that the report should be received as information and continued until next year, and I would like to have the opinion of the members. I think we would gain, in that we would get additional information. As Mr. Coburn has said, in his report to the American Railway Engineering Association, the subject is one of continuous study. Was not the report so received in your organization, Mr. Coburn?

Mr. Coburn:—Certain conclusions were adopted but the report was considered incomplete.

The President:—I would suggest that some one make a motion to that effect, in case it is agreeable.

Mr. Lichty:—I would say, for the information of all concerned, that Mr. Fullem admitted that the report was gotten up in rather short time, and he thought they could improve it considerably if it were carried over. For that reason, I, personally, should be very glad to see it continued. I think we would get some very valuable information in addition to what we now have. The discussions tonight will make good material for our proceedings.

Mr. Andrews:—As a member of that committee, I think I can say that the committee did not consider the report as conclusive. We felt that we had gained all the information possible at the time, and we compiled the report accordingly. In the discussion tonight and in any discussion that might take place in the future, there are undoubtedly questions which will come up that will be of value to the committee. The only thing that I can see brought out tonight is the question of the relative value of coal tar and asphalt. Now if the manufacturers of the different products are willing to give the committee all the information that they ask for relative to the composition of their product, then I think it would be a good thing to carry it over, but unless they do, I see no benefit whatever in carrying the report over to the next meeting or to any other meeting. I am however, willing, as a member of the committee, to work on it another year, or two years or three years, if this association so desires.

Mr. A. S. Markley:—I believe we should continue the subject another year, because of some criticisms in the report that I couldn't catch or carry in my mind, in reference to tile and slate being an ornament rather than a roof. If it is carried over another year, I will be able to say something about that.

Mr. Andrews:—I do not think that any one is entitled to say that slate is an ornament.

Mr. O'Neill:—How much easier it is to criticise than to give advice of any value! We can all criticise, but I do not believe that many of us can give advice of any value as to the difference between a coal tar and an asphalt roof. I have had considerable experience with these roofs, but I am not prepared to say which is the better. I have had good roofs of each material and I have had some very poor ones, and this question is purely an educational one. We are all at the beginning yet, and I think this committee, if the subject is carried over, can get some information that will be of value to us in the future. I move that the report of this committee be accepted as information, and that the subject be continued for another year.

(Motion seconded.)

The President:—Before putting the motion, I wish to say, that it would seem advisable to continue the committee as well as the subject, because it would be a matter of immense regret if the experience of the committee thus far should not be taken advantage of.

The motion was carried.

Mr. Wardell:—I wish to state that we will be glad to have any gentlemen interested in this subject, visit our mill, go into the manufacture of the fabric as well as the peculiar substances that we use, from beginning to end; and I will come from New York to meet any committee or any individual that is interested, and will not only explain the methods we employ, but will show the material and give them, as well as I can, the reasons why we use the material. There is nothing that we have that we wish to keep secret. There is nothing that we have that every other manufacturer cannot get just as well as we do, if he is willing to pay the price. The only thing we ask is to have the gentlemen of this committee give us their time and attention, if they will, and we will do our best to give them every bit of information we have on the subject.

Subject No. 11.

METHODS OF PROTECTING EMBANKMENTS AGAINST CURRENTS AND RESTORING THEM WHEN WASHED OUT.

(Continued from last year.)

REPORT OF COMMITTEE.

We submit as our report a detailed description of practice in the protection of railway embankments and river banks in nearness thereto, as contained in several letters from members of our association, together with descriptions and illustrations of brush mattress work by the Mississippi River Commission, and of the Kerr gabion system. All of this information appears to us to be practical, and applicable to railroad situations, for it is frequently the case that vanishing river banks threaten the foundation of a railroad paralleling the stream. The only escape from destruction then lies either in changing the location of the railroad or in preventing further encroachment of the erosive currents. Therefore, railroad embankment protection often resolves itself into a scheme for river bank protection. When railroads have extensive works of this character to construct much valuable information that is of direct application can be obtained from the annual reports of the chief engineer, U. S. Army.

Individual contributions to our report, which came in response to inquiries on the subject by the committee, now follow.

R. H. Reid, Supervisor of Bridges, Lake Shore & Michigan Southern Ry.:—On the L. S. & M. S. Ry. we have used several methods of embankment protection. One kind is heavy breakwater stone, where there is washing and pounding of waves, as, for instance, along the shore of Lake Erie and along Sandusky Bay. This protection is sometimes supplemented by filling in between the large breakwater stone with smaller ones, which can be thrown off the cars by hand or shoveled off with train plows. The breakwater stone can be placed to advantage, of course, only where they can easily be rolled down the bank or where the work is within range of a derrick boom.

Another method of embankment protection is the use of barbed wire or woven wire fence, which is sometimes spread along the embankments where water is cutting or washing, and sometimes is filled in with underbrush or other material so as to form a mat, making, in many cases, a very effective protection.

Another form of protection is to spread brush wood or underbrush along an embankment, covering it over with lighter and similar material which will interweave with the brush and form a solid mat, similar to that formed by the woven wire fence.

Another method, which has been used at times, is to drive a row of piles along the embankment which is in danger, sometimes also placing plank or timber on the back of the piles and filling in back of them, laying the timber as low down in the water as possible, in order to prevent undercutting. This frequently affords a very effective protection against wave washing as well as against the action of the current of streams.

J. M. Bibb, Supervisor of Bridges and Buildings, Louisville & Nashville R. R.:—One way to prevent an embankment from being washed out by river current, where the current strikes the fill, is to riprap the side of the fill with stone. To protect the off side of the embankment from being washed in event the flood should not go over the track, that side also should be riprapped. Should the current begin to cut under the track the action can be stopped by throwing in gunny sacks filled with sand or common dirt.

What to do after an embankment has been washed out depends largely upon circumstances. If the fill washed out is not more than 10 or 12 feet high, the quickest way to resume traffic is to crib up a support for the track with ties or other timbers or erect temporary bents, but if the water is in the way, especially if the current is swift, the best thing to do is to drive pile bents and build over them. If a driver is not available, place the posts and work them down to as good a bearing as possible; cap them and run cars over to settle them down, and keep blocking up until they are down.

At the Alabama River, where the L. & N. R. R. crosses near Montgomery, we discovered last summer that one of the spans had moved a little, and it was decided to have divers make an examination of the foundation of the piers. Upon investigation we found the round pier under the draw span, and also the pier on each side had been very badly undermined. The material under the round pier had washed out on one side about 8 or 9 feet deep. The water was about 12 to 14 feet deep, at low stage, with some current. We placed 30 or 40 carloads of large stones from ½ cu. yd. to 1 cu. yd. in size around the pier, but 5 or 6 ft. clear of the pier, and piled them up within 2 or 3 ft. of the surface of the water. We then lowered concrete in iron buckets 3 ft. square, with drop bottoms, down to the bottom of the river and dumped the concrete until we put in about 80 or 100 cu. yds., which is standing all right now. Our object in dumping the concrete between the pier and the stone that we placed around the pier was to compel it to run under the foundation.

J. M. Mann, General Foreman, Ft. Worth & Denver City Ry.:—We have been figuring on putting in some concrete slab protection, but owing to the slack period in business we have not done this work yet.

We have had a great deal of experience on the F. W. & D. C. Ry. in protecting our banks, as there are a number of rivers and we have been fighting them for a good many years. For riprapping banks, where it is not necessary except in case of overflow, I think rubble stone is about the best thing to use. We are putting in stone on banks for about 30 cents per square yard. Wherever we lay up the stone in shingle fashion we have never had any trouble. We have a number of banks approximately 10 ft. high which have been riprapped in this way for eight or ten years, and frequently the water comes up over them to within 2 ft. of the ties; and yet we have never, in any instance, lost a bank when protected with rubble stone in this manner. Of course, I would not recommend such work for streams where the banks are caving in.

On river banks we get best results by putting in cribs or pens about 10 ft. wide, flooring them with old stringers or poles. We build the crib in the water and sink it with stone as we build it, the crib to connect with the bank at the upper end and extending out into the stream at an angle of about 30 deg., pointing down stream. We build them to stand 8 or 10 ft. above high water. As the water rises the crib settles, in most cases, but we keep building them up and filling them with stone as fast as they settle. After two or three floods the crib will stop settling and a sand bar will form at the back of it, after which we have no further trouble. This work costs us, all told, approximately $1.50 per cubic yard, including the stone placed in the crib and the material used in making the crib.

We have also tried to protect a number of places from washing by placing barbed wire fence along the bank, anchoring it out in the river and letting it float. So far we have not had much success with it.

C. F. Green, Supervisor Bridges and Buildings, Southern Pacific Co.:—The rivers in northern California are very peculiar, inasmuch as they have been filling up for years with slickings washed from the mountains by hy-

draulic mining, so that at the present time the beds of the rivers in some places are higher than the adjacent land, and the banks must be protected by levees. We have five rivers and numerous smaller streams on the Sacramento division that we either run along or cross, and during high water we are kept constantly on the watch for washouts. All openings, such as trestles and culverts, are riprapped with granite rock or willow mattresses, but we find the cost of granite rock high—about $3 per cubic yard, in place. The mattress will not last, so we are now using concrete matting of 6 inch thickness, reinforced with fence wire, which we find is much cheaper than the granite rock.

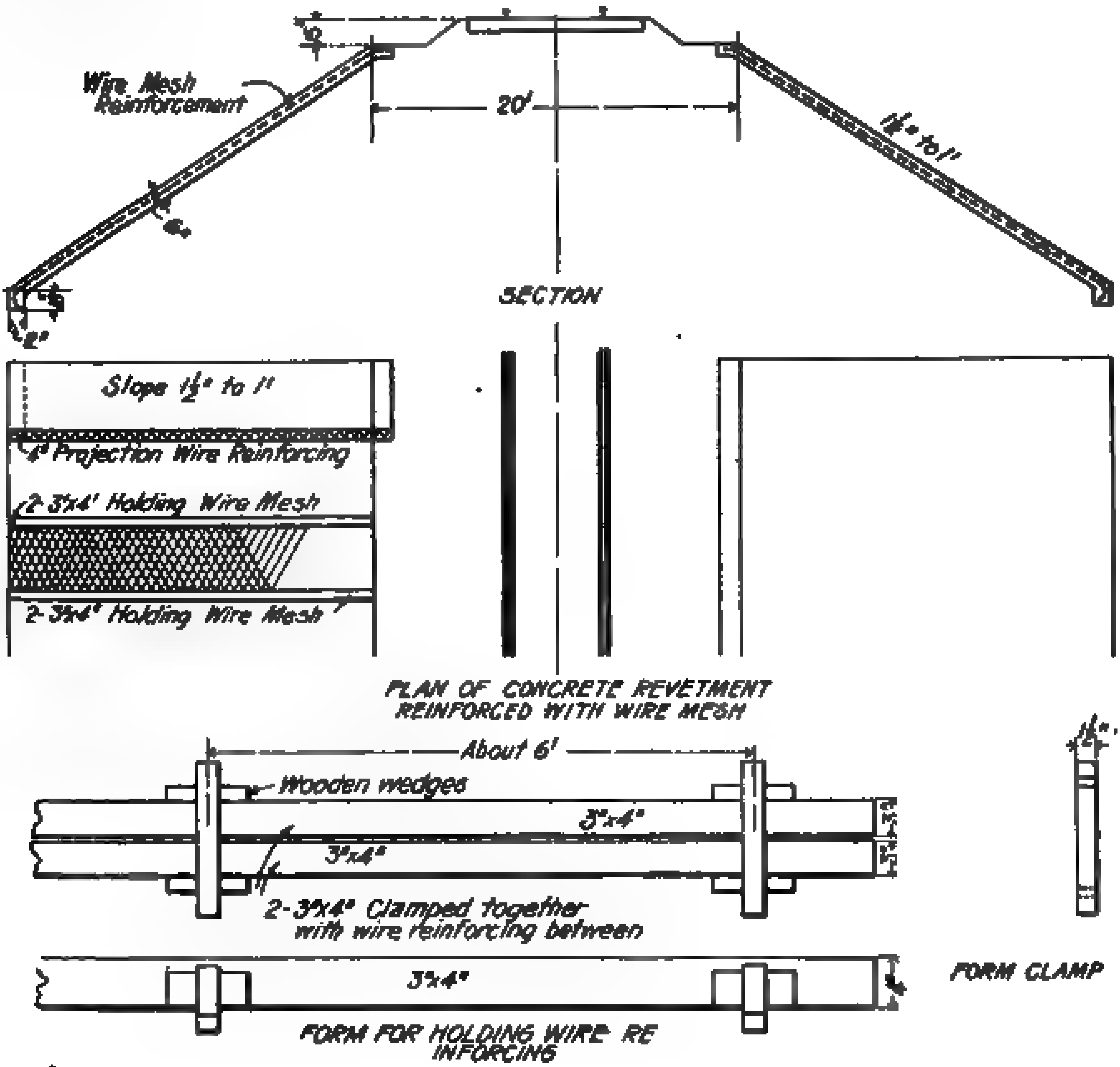


Fig. 1.—Reinforced Concrete Slab Bank Protection, Southern Pacific Co.

TEMPORARY PROTECTION OF EMBANKMENTS WHEN PERMANENT WORK CAN NOT BE DONE.

For years past, in times of high water, the Southern Pacific Co. has used granite rock by the car-load, dumping the same down the embankments to stop the washing, but we find it unsatisfactory for the purpose unless used in large quantities. We also find it slow material to handle, and during later years on this division we have used the brush mat, which can be placed in current swift enough to wash rock away weighing a half ton. If possible we cut the brush as long as the slope or bank of the washed fill and make it

into bundles by tying together with baling wire or small rope about every 3 ft. along the bundle, which is as large as can be carried by three or four men. We then place these bundles along the track at the wash, close together, the small ends projecting toward the water, and fasten the bundles together with baling wire until we have bundles the full length of the wash. We then take a heavy line that will hold the mat in the stream, make fast one end of the line around the down-stream bundle at about the middle, and from that around all other bundles, until we come to the last one up stream, where we tie the end of this line to a tree or dead man up stream where it will hold the mat against the washed bank when afloat. Next we take a number of small lines (old ones will do) about the length of the bundles, fasten one end of these lines to the bundles, about 20 ft. apart and at the end next to the water, bringing the lines up lengthwise of the bundles. We then start at the up-stream end of the mat and shove it overboard, holding on to the short lines, so that the mat will not swing away from the bank or clear of the bank. In fact, we leave about two or three feet of the mat on top of the bank after shoving into the water. We then take some worn-out rail, long enough to reach from line to line fastened to the outer ends of the bundles and, starting at the down-stream end, hold up the short line and heave out the rail upon the mat as far as possible under the short lines, and continue doing this the full length of the mat. The rails will sink the mat down, and if we get the rails out on the mat where the small ropes are fastened, by hauling in or letting out on the lines we can bring the end of the mat right to the base of the wash and stop it.

We have found the brush mat made in this way the most feasible plan in times of emergency. In fact, we stopped washing action 18 to 20 ft. high and 200 ft. long, at points back of a U-abutment of an approach to a steel bridge, by using a brush mat in this manner.

PERMANENT PROTECTION OF EMBANKMENTS.

On revetment work we have used riprap of split granite rock or round rock dumped on the fill, with no satisfaction unless placed in large quantities; but if laid with the face chinked and pointed up it will make a fairly good job. The trouble with this kind of work is that the fill gets wet and settles, breaking up the face of the rock until the water scours out the fill back of the rock, thus displacing large masses of it. We are now using, and have been using for the last two years, a concrete slab of 6 inch thickness, with a wire netting in the center of the slab as a reinforcement. We find this a very good device, and it is cheap. In one case where it was placed on a new fill that settled badly, it did not pull apart and did not allow the water to wash the fill.

Following is the cost of a reinforced concrete revetment of 6 in. thickness for a works of 376 sq. yd. surface measure:

MATERIAL.

2 rolls fence wire, 50 rods, at 45c per rod,	$ 22.50
82 cu. yds. gravel and sand at 30c per yd.,	24.60
82½ bbls. cement at $1.70 per bbl.,	140.25
Total cost of material,	$187.35

LABOR.

Building mixing platform,	$ 11.50
Unloading gravel,	25.00
Unloading cement,	10.50
Putting up forms and reinforced wire,	116.50
Placing concrete,	119.00
Total labor,	$282.50
Total cost of material and labor,	469.85

The design of the slab is shown in Fig. 1. We graded off the slope to the standard 1½ to 1 slope and dug a trench 12x18 ins. around the bottom of the slope, placing the end of the wire in the center of the trench, allowing the wire to lie away from the slope. We next filled in the trench with concrete. When this was completed we took a piece of 3x4 in. lumber, the length of slope, and placed it up the slope at the edge of the wire and another piece, with one width of the wire over them. We then took two other pieces of 3x4 and placed them on top of the first two pieces, and, by using molder clamps and wedges, clamped these two pieces together so as to hold the wire tight between them. We then cut some 1x4-in. pieces about the length of the width of the wire, and drove them between the two top pieces of 3x4 in. This stretched the wire up tight and gave us 3 inches under the wire and 3 inches over the wire, also leaving, after the concrete was in place, when the four pieces of 3x4 were removed, 4 inches of wire sticking out of each side of the concrete slope.

This was done with alternate sections of wire which gave us a space up the slope without walking on the new concrete. When all of the odd widths of wire were in place the length of the revetment, we started and took out the 3x4 in. forms and then laid the alternate sections of wire. These were fastened to the stub ends of wire that were left sticking out of the first concrete by tying it with small wire. We then filled in with concrete. This gave a continuous wire in the center of the concrete throughout the revetment and made a good-looking face.

I think this work will stand longer than any other kind that we have tried. I give the cost per day of the gang, so that the cost of the labor can be compared as against work at other places where cheaper labor can be had. We worked 10 hours per day. We had one foreman at $4.50 per day; one concrete mason, at $3.25; six laborers, at $2.25; three laborers, at $2.50.

A. M. Van Auken, Chief Engineer, Memphis, Dallas & Gulf R. R.:—Roughly, we may describe bank protection as falling in three classes:

(*a*) Where the banks and bottom of the stream are stone, stony or consist of other substance not washable by the force of the current, and where it is only the railroad grade that is to be protected.

(*b*) Where the bank and bottom, or at least the bottom of the stream, are of gravel or coarse sand and have considerable resistance to the washing power of the current.

(*c*) Where the soil is alluvial, and the rivers shift their courses at will.

As to treating these various conditions there are many methods. We may, however, classify the successful ones as four. For Class "a" there seems to be nothing equal to riprap. There is but little need to speak of this here. It consists of stones laid, or, even thrown, on the slope of the roadbed at points where injury is threatened. The size of the stone used is governed by the velocity of the stream, the drift it carries, and the ice forming in it. Ordinarily the needed size may be judged by the size of the stones left in the bed of the stream. If these be not larger than "one-man stone" (of a size readily handled by one man) the embankment will be safe if protected by stone of that size. There is seldom any economy in using stone smaller than this.

Mountain torrents, streams carrying large drift and, worst of all, streams which freeze deeply or carry heavy floating ice, present serious problems for riprap. Where ice forms a foot or more thick against a bank the rising water will lift heavy stone from place. Under such circumstances only very heavy stone, placed with a derrick, will give adequate protection.

For Class "b" a form of protection recommended by Mr. A. E. Killam will usually give most excellent results. On the Wisconsin and upper Mississippi Rivers wing dams built of brush weighted with stone have given most excellent protection, at points where the stone used as riprap would soon be buried by their own weight sinking them in the sand. This form of protection, like riprap, is so common, and the differences in the way in which it is used are of such minor importance that a more complete description is hardly necessary—it is merely riprap with a foundation of brush.

For Class "c" there seems to be no best system. If you will recall

your individual troubles in controlling water on leaky roofs, in leaky pails and in leaky cisterns you will have in mind what a volatile and capricious substance you are dealing with. Then, given such a stream as the Arkansas, Red or Missouri or Mississippi, with a flood volume running up into thousands of feet per second of discharge, the velocity with which it moves at flood time, and the impact with which it strikes the bank, and you will realize that no form of protection should be expected to hold against the ever changing attack of so powerful a foe unless such protection is constantly watched when threatened, and strengthened as the force of attack changes to the weak or weakened points.

Then we have the further problem of continual changes in a channel due to various construction operations in and adjacent to a stream. The erection of a bridge pier or boat incline may change the course of a stream to an astonishing extent. The slight increase in the velocity of the stream at a particular point, say from 2.94 ft. per second to 3.06 ft. per second, will destroy a bank which would have resisted indefinitely under the former condition. A snag or sunken steamboat may cause this. The successful control of a large stream, as the Missouri below Sioux City, and the Mississippi below Grafton, requires constant and intelligent watching.

The forms of protection which have given entire protection successfully on these streams are two. The first, and undoubtedly the best, is the mattress. Where brush are procurable at a fair cost they are commonly used. On the lower Mississippi mattresses have been built of cypress boards. This method is described in Camp's book on track, and in an article in the Engineering News, June 5, 1902, by Mr. W. R. De Witt. Mr. De Witt speaks from many years' experience with rivers of this class, and no one, to my knowledge, is equally well informed as to the particular problems there presented.

The only other system which has given any measure of protection in this class of stream is the permeable pile dike. This consists of from two to four rows of piling driven at right angles to the bank, framed together and braced to resist the action of ice and drift. On the up-stream row are fastened two or more rails, much as are the rails of a picket fence, and to these are fastened, perpendicularly, poles which reach the bottom, and extend nearly or quite to high water. It is very much in form like the common picket fence. Its action is to retard the flow of the water, as it passes through it, and cause it to deposit silt in the comparatively still water below the dike, thus building up a deposit or sand bar, and ultimately cultivable land. These dikes must be so close together that the eddy caused by one dike will be caught by the dike next below and broken; otherwise the eddy would wash out and destroy the deposit.

The mattress style of protection is best, but is more costly. Its only failures, to my knowledge, are where the protection was only partial. If the mattress does not go out to the central thread of the deepest water of the stream, the water will work under the edge and destroy the mat. If it does not extend to a point above, and to a point below, where the force of the stream strikes the bank, the water will cut around the end of it and destroy it. Of course, the bank of the stream above low water, and extending to above high water, must be protected by our friend riprap. With the permeable pile dike it is usually necessary to protect the bottom of the stream under the dike with a mat.

The failures at bank protection works are legion. Among those which had great ingenuity back of them were the "fox-tail" dikes experimented with on the Missouri River in the latter seventies. They were composed of saplings somewhat longer than the water was deep, the lower end anchored to the bottom by a rock of sufficient weight to hold it in place and the top attached to a barrel to keep it afloat after it became clogged with deposit. As a temporary expedient these dikes are a great success. They will divert a current of water from a bank in flood time, and may be used to save a town from a river change during high water, as they can be planted in any stage of water, and if one be washed away another can be planted to take its place. As a permanent protection they are of little use, each succeeding high water calling for more or less renewals.

The most complete failure was with what were called "bankheads," much used on the Missouri in the later years of the Missouri River Commission. Briefly, it consisted in forming the bank into easy bends, and protecting the point or promentory, the theory being that the river would then form into a bend around the bankhead and behave itself. It refused to behave, and the work, costing a couple of million dollars, failed utterly in accomplishing its end.

Numerous "systems" have been brought out, tried with indifferent success, and, so far as I know, all ending in complete failure. Those who may wish to read up I would advise procuring from the chief engineer, U. S. Army, the appendixes to his reports covering the streams in the vicinity of his work. The report of the Mississippi River Commission has the most material of value. The two engineer districts covering the Mississippi from Cairo to Grafton and from Grafton to St. Paul, and those covering the Missouri, the Arkansas and the Red are the most useful to an engineer having to deal with alluvial streams.

A partial list of the articles in periodicals relating to this question are as follows:

"Bank Fascines," Engineering News, March 26, 1896.

Banks to Resist Wave Action—Proc. Amn. Soc. C. E., Nov., 1896; Trans. Assn. C. E., Cornell, June, 1896; Engineering Magazine, Dec., 1897; Nat'l Geographic Magazine, June, 1901.

Bank Revetment—Engineering Magazine, June, 1896; Proc. Amn. Soc. C. E., June, 1896; Engineering News, Oct. 31, 1901; Engineering News, June 5, 1902; Proc. Amn. Soc. C. E., Jan. and April, 1905; Engineering Record, Aug. 18, 1906; Engineering News, Oct. 22, 1908; Engineering News, Dec. 10, 1908; Engineering News, Jan. 14, 1909; Engineering News, Jan. 28, 1909; Engineering News, April 8, 1909.

If time would permit I would like to give a history of the two cases at Eliza Point, Ill., and Bird's Point, Mo., just above and opposite Cairo, Ill. The Bird's Point case was treated by makeshifts and Eliza Point was protected. The former work resulted in a loss of property of close to $150.000 by the St. Louis, Iron Mountain & Southern Ry. and the St. Louis Southwestern Ry., and the latter saved the city of Cairo from being cut off and left on an island.

BRUSH MATTRESS WORK OF THE MISSISSIPPI RIVER COMMISSION.

The Mississippi River Commission is now weaving and sinking a fascine mattress at Delta Point, La., opposite Vicksburg, Miss., for protecting the river bank which is caving and encroaching the right of way of tracks of the Vicksburg, Shreveport & Pacific Ry. The photographic reproductions and line drawings convey a good idea of how the work is being handled. Fig. 2 shows the mattress barge and the process of weaving the mattress; Fig. 3 shows the mattress floating in the river as the barge is worked away from the completed part of the mattress; and Fig. 4 is a view looking over the mooring barge, at the head of the mat and towards the mattress barge. Figures 5, 6 and 7 illustrate the method of making the fascine mattress.

A thorough knowledge of the river in the vicinity of a reach to be protected is of great importance. Much money can be wasted by not studying the movements of currents and bars in the locality, in order to select the best point for beginning the work. If placed too high under the bar, dead water may soon prove it a waste of material and an unnecessary expense, while at localities where the bar is receding the failure to place the upper end of the work at the correct place may prove disastrous. A careful survey of the river in the vicinity is very essential.

A mattress 300 ft. wide by 1,200 ft. long represents a superficial area of about 8 acres, and when one realizes that this vast willow carpet, over a foot thick, is placed on the bottom of the river in depths of from 40 to 100 ft.,

Fig. 2.—Mattress Weaving, at Delta Point, La.

Fig. 8.—View of Mattress Weaving, Delta Point, La.

Fig. 4.—View from Mooring Barge to Weaving Barge, Delta Point, La.

Fig. 6.—General Plan of Fascine Mattress.

and against currents of from 5 to 8 ft. per second, the difficulty of the enterprise will be appreciated.

A complement of men for a mat 200 ft. wide is 54, under a foreman, divided into three equal gangs, each under a master laborer. Each gang consists of five men on the brush barge passing brush to the weaving party, twelve men in each weaving party, and one man on the mat mauling the brush tightly into place as the weavers push it down. Each gang builds one-third the width of the mat. The brush barge is placed outside (below) the mattress barge, about midway between the two ends, and a barge loaded with poles is hung to each of the said ends.

We give below, from a report of the chief of engineers, U. S. Army, cost data and the method of building a fascine mattress during the season of 1893 at New Madrid, Mo., which was the first large fascine mattress made. The work consisted of a continuous mattress 250 ft. wide by 900 ft. long and 12 inches thick, an auxiliary connecting mattress, and a shore paving of 4 in. of spalls and 6 in. of stone extending up the graded bank to the 27-ft. stage. The cost of this work per lineal foot was as follows: River mat fascine, $15.62; connecting mattress fascine, $2.32; paving mat fascine, $7.58; superintendence and care of plant, $2.26; total, $27.78. During the construction of the mat the weather was very favorable, and the river remained practically at the 10-ft. stage.

Labor:—The supply was not very abundant. Whites, subsisted by the government, were employed in all responsible positions. At first the common laborers were white and self-subsisting, but owing to the hot weather and hard work, they were soon replaced by negroes. The price paid was $30 per month and subsistence. The self-subsisting laborer received $1.25 per day of eight hours.

Material:—Brush and poles were obtained by contract at $1.05 per cord for the former and $1.50 per cord for the latter, and the source of supply was from 10 to 30 miles above the work. The deliveries were not sufficient, owing to the fact that the estimated quantity to be used per day was too small. Stone was obtained by contract from the quarries and stores on the bank during the spring.

Fascine Mattresses:—The method of holding the barge and the mat, by means of cables fastened on the bank, was the same as in previous years.

A set of platforms or fascine barges were used in addition to the mat barges, and joined to them longitudinally. The platform barges were ordinary barges with an extra deck raised to the level of the platform of the mat barge. Along the side of these, joining the mat barges, forms were built in which to construct the fascines, the tops of these formers being at the same elevation as the highest point on the mat ways. Under the platform of the mat barges were placed 19 reels 13 ft. apart, the two outside reels containing 3/8 in. and the others 5/16 in. galvanized steel strands (made of 7 wires each). These are the bottom cables, and the ends of each were made fast to the head and under the mat at right angles to the fascines. Each cable was in one piece, its length being determined by the length of the mat. Friction brakes were used on the reels to keep the cable taut.

The method of procedure during the construction of a fascine mat was: First a large head, about 3 ft. in diameter, was made of hardwood poles, the diameter of the butts of the poles being from 4 to 8 inches, and to this head were fastened the bottom cables. The weaving strands, which were 1/4 in. galvanized steel strands, composed of seven wires, were also fastened to the head at the same place as the bottom cables, and hence there were nineteen of these 13 ft. apart.

The fascine was made by placing brush from 1 to 4 inches in diameter at the butts in the formers and compressing them into round bundles or fascines 12 in. in diameter, by means of the lever chains. While thus compressed they were tied together with No. 12 galvanized steel wire. Care was taken to keep the butts well scattered. The fascine was next raised out of the formers and pushed to the ways and down to the head, when the weaving cables were passed over the fascine, then down under the fascine, and the bottom strand up between the fascine and the head. Then a pair of 6 in blocks, one end fastened to the mooring barges and the other (by means of a "Haven" clamp) attached to the weaving strand, and six men at each set of blocks pulled the fascine down to the head. While the strain was on the weaving strand it was either clamped to the bottom strand or held so that the fascine could not separate from the head, or one from the other.

Fig. 6.—Part of Head in Mat. No. 1.

Fig. 7.—Part of Head in Mat. No. 2

by driving a staple into the butt of a willow so as to take both the weaving and bottom cables. The weaving and bottom cables were clamped together, at every tenth fascine, besides being stapled, so that the fascines could not slip apart. This method was continued until the mat was built of the desired length.

The labor on the mat was divided into three parties: One party unloaded the brush off the barges; the second party carried the brush to the formers and made the fascines; the third party assisted the second in raising the fascines out of the formers down on the ways and tied them together. When the ways were filled, the friction brakes were raised and the launch made, the brakes being put on again just before the launch was completed, so as to get a uniform strain on each cable.

In order to strengthen the mat, five longitudinal wire strands, 26 ft. apart, were placed over its whole length. The first one was on the outside of the channel edge, and of ½ in. diameter, composed of nineteen galvanized steel wires; the second was also ½ in. and the remainder were ⅜ in. diameter, composed of seven wires. These strands were fastened to the head of the mat at the same place as the other strands, and were clamped to the weaving strands at every tenth fascine, the clamps being so arranged as to come half way between those on the bottom of the mat.

The shackle straps were fastened to the mat by first taking a turn around the head, then circling two or three fascines about 10 ft. from the head, and next clamping to the top strands. Seven shackle straps were used, the two nearest the shore not being backed up with a top strand. In order to give the mat the necessary rigidity in sinking, longitudinal poles of 3 to 8 in. diameter at the butt were placed over it, the rows being 13 ft. apart, and fastened to the mat with No. 12 galvanized wire and No. 9 copper wire. The ties were 4 ft. apart, one of copper and the next two of galvanized wire. These wires encircled a fascine and a pole. Care was taken to keep the galvanized and copper wires well apart, so that no chemical action could take place and destroy the wires.

At first the progress of the construction was slow, owing to the fact that the labor was untrained and that the fascine mat was an experiment;

but after the details had been worked out fairly good progress was made. Mattress construction was begun on July 27 and completed on August 16, when the mat was sunk.

Brush used per square, cords,	$1.60
Poles used per square, cords,	.05
Stone ballasting, cubic yards,	.57
Total cost of mat per square,	$6.25

Grading:—There was not much grading to be done, as the bank had nearly a 1 on 3 slope, except at the upper end, where graders had to be used. Hydraulic grading began on Aug. 17 and was completed Aug. 25.

Bank graded, linear ft.,	360
Material moved, cubic yards,	2,154
Cost per cubic yard,	$ .08

The excessive cost was due largely to a pile of very compact sawdust which was removed with difficulty.

Connecting Mattresses:—Narrow connecting mats were placed along [illegible] entire bank protected, as the river mat did not come up to the water's [illegible] These were built on the ways, of the old type of mattresses, and [illegible] launched in place.

Total length of connecting mats built, including laps, linear ft.,	[illegible]
Average width of connecting mats, ft.,	[illegible]
Total built, 155.5 squares, sq. ft.,	[illegible]
Brush and poles used per square of mat, cords,	[illegible]
Stone (ballast and sinking) per square of mat, cu. yds.,	$ 2[illegible]
Cost per square foot in place, cents,	15.63

The quantity of stone used was large, as an extra amount was placed on the mat from the zero to the 10-ft. contour.

Paving:—Preparatory to paving, the grade was neatly dressed. Paving began at or near the 8 ft. contour and extended to the 27 ft. contour. The spalls used in paving were from 1 to 10 pounds in weight, and the stones weighed from 10 to 40 pounds. The average thickness of the paving was 10 inches, 4 in. of spalls and 6 in. of riprap. The length of bank paved was 900 ft.; the area of bank paved 8,001 sq. yds. The total cost, exclusive of grading, was 8.35 cents per square yard.

SUMMARY.

	Per Linear Foot.
River mat, 900 linear ft., 2,250 squares, cost,	$15.62
Connecting mats, 900 linear ft., 155.5 squares, cost,	2.32
Paving, 900 linear ft., 72,008 sq. ft., cost,	7.58
Sundries (superintending, care of plant and repairs),	2.26
Total cost per linear foot,	$27.78

The 900 linear feet of revetment cost $25,000.

THE KERR GABION SYSTEM.

In describing this system it is proper to explain that its development is being fostered by the need of a method of protecting caving banks which would be commensurate in cost with the value of the property requiring protection. The standard rock-filled piling jetties have in cases given good service at costs varying from $8 to $15 per lineal foot of jetty, and in many cases have yielded results directly opposite that for which they were constructed, not infrequently being found, after a few years, on the other side of the river, which has made a new channel behind them. In other cases they are washed into two pieces, the river breaking through the middle.

Fig. 8.—View of Arkansas River, 8 Miles Below Little Rock, Before Installation of Kerr Gabions.

Some of the work of the Kerr gabion system is shown in Figs. 8 and 9. In this case the river was digging a very deep bend at the place toward which the steamboat is pointing and taking away land in large quantities, forming a new channel and slowly closing the old channel to the right of the middle bar shown in Fig. 8 by connecting it with the main bar on the opposite shore. The steamboat is just entering the new channel at low water, the old one being already too shallow for navigation.

At this juncture the owner of the land entered into contract with the River, Rail & Harbor Construction Co., of Jackson, Miss., for the installation of the Kerr gabion system. At a period when the river was high enough to carry a large amount of sand and make the shoal channel navigable, the jetty shown at the upper end of the sand bar in Fig. 9 was put into the swollen stream, with the result that the low water channel was within a few weeks filled with sand and within three months the immense sand bar shown in this picture was built. High water thereafter became more and more sluggish in the old bend and caving grew less and finally ceased. This bar is 1,700 ft. long, 400 ft. wide and the depth of the fill varies from 2 to 22 ft.

This gabion is graded in height from 8 ft. to 16 ft. and is 600 ft. long, being constructed entirely of oak and willow cut near the site, in the manner shown in Fig. 10, which is a picture of a smaller gabion placed at another point. Occasionally steel arches are used in the construction to add weight to the structure, to sink it and hold it to the bottom. The very important feature of anchoring and holding this work in place is accomplished by sinking large concrete blocks into the sand by a hydraulic jet, to which are attached steel anchor cables made fast to the gabion.

The gabion works on the well known law of sedimentation (gravity). A stream running rapidly carries much sand in suspension, sometimes as much as 50 per cent. If the flow or velocity of the stream is then reduced by the introduction of a pervious gabion jetty which allows, say 50 per cent of the water to pass through the same while the other half is shunted around, a

corresponding reduction in the velocity of the stream is effected, and a deposit of the sand which it is not able to carry at the reduced flow. By varying the mesh of the lacing one can secure different results in carrying the deposit of sand close to or far below the gabion, as may be desired by the conditions.

The length of the bank protected in this case up to this time is 1,700 ft., not to mention the saving effects of the deflection of the current from the banks farther down the stream caused by the sand bar. All engineers who have had experience with rock-filled piling jetties in our rivers know that substantial precautions must be taken in their construction at the channel ends to offset the destructive effect of the intense eddies set up at this point. The design of the gabion jetty is such that this eddy is broken up into thousands of small eddies devoid of harmful effect. On the basis of the total contract this particular gabion would not cost more than $4,800, and a piling jetty of the same length would have cost $9,000.

Figure 11 shows the plans for repairing an old solid dike at the C. R. I. & P. Ry. bridge in the city of Little Rock, which has been submitted to that company recently. This work is to be put in for the purpose of maintaining the low water channel under the draw span of the bridge. At present the new channel is forming under the fixed span through the gap in the old piling jetty. A similar instance to this is one on the Cotton Belt road at Rob Roy, on the Arkansas River, where the channel moved to the opposite shore, leaving the draw span, so that company has put in another draw span over the new channel. Thus railroads are often put to enormous expense because of delay in taking action, for the control of channels requires time.

The gabion work of the Kerr system in most cases has been made of willow and oak materials secured near the site of the work. Construction for the coast of the Gulf of Mexico, placed to protect a railroad from being washed away by the storms and for building up the beach of the coast along the railroad, which was built to stand the blows of the surf and the breakers during storm, was constructed of arches made of oak bent after steaming the timber, making it very stiff after it was braced on the inside. This work was laced with sawed dimension stripping, all of it being creosoted.

For emergency revetments the work is built cylindrical in form, and the cylinders, one after another, are put to the bottom of the river, strung on cables which have previously been anchored in the bottom of the stream. These cylinders have cross-sectional partitions and they at once deflect the water, acting much as a mattress would act. These cylinders are made as a rule about 5 ft. in diameter and they soon fill up with sand and thus make a solid bank.

Fig. 10.—Constructing a Kerr Gabion 7 ft. High and 200 ft. Long.

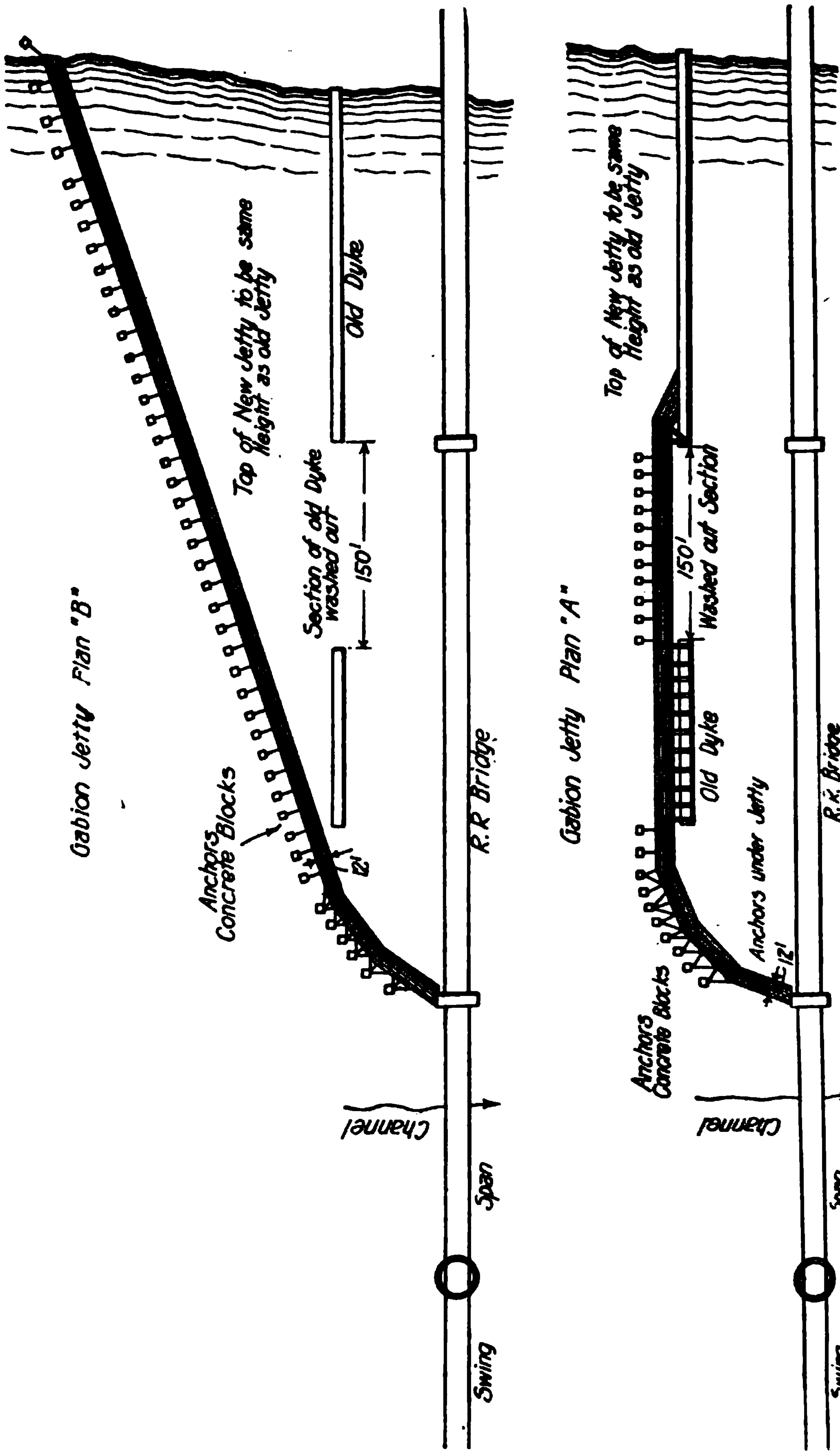


Fig. 11.—Proposed Repairs to Jetty at C. R. I. & P. Ry. Bridge at Little Rock, Ark.

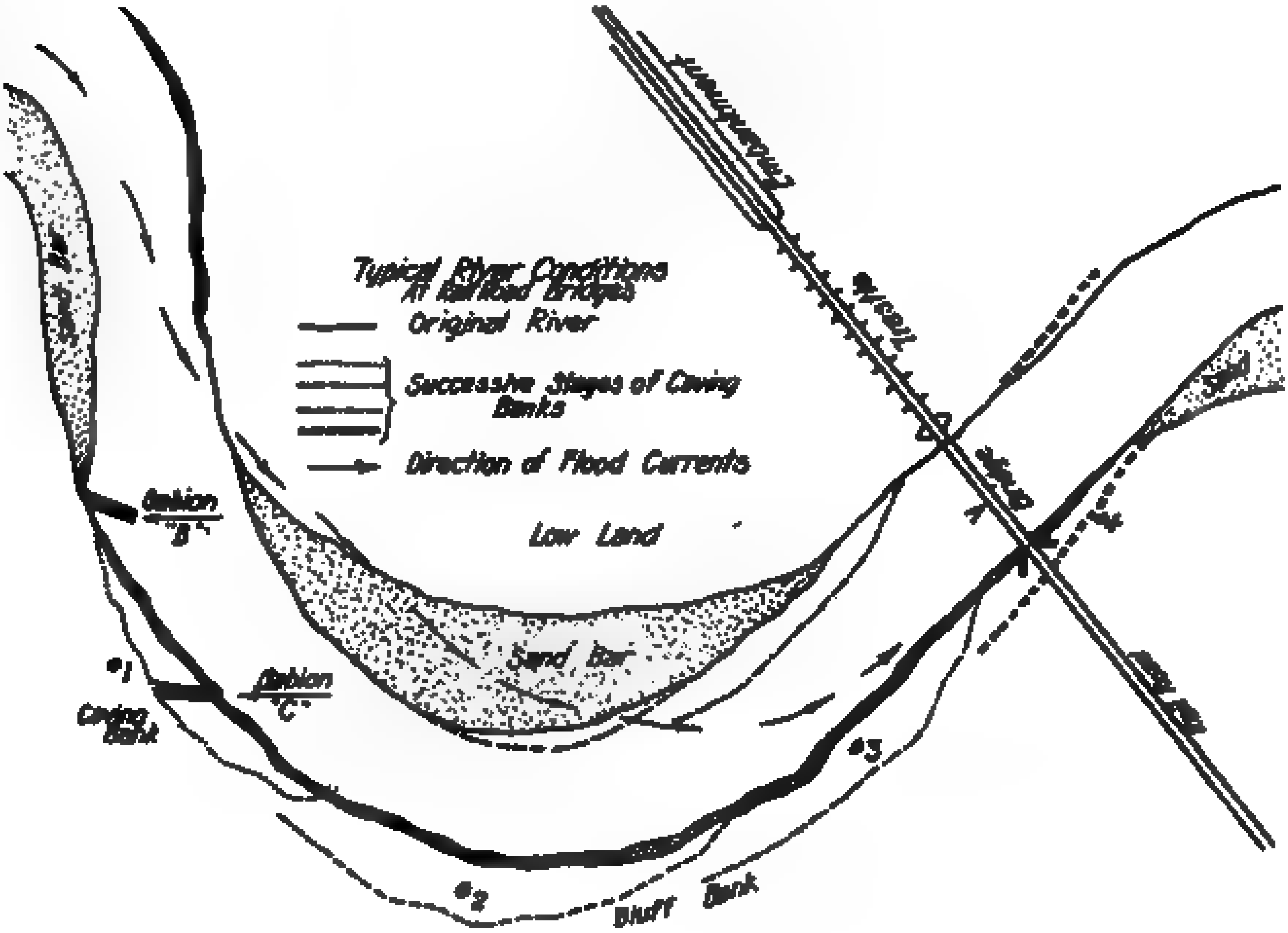


Fig. 12.—Typical River Conditions and Means of Protection of Bridge.

Fig. 13.—Kerr Gabion System Applied to a Washout.

Much trouble could be prevented if the parties concerned would take action in the matter of protecting banks or protecting bridges in time to avoid the crisis, as, for instance, in the case where a river starts to dig a

bend up-stream from a bridge, say a mile away, and it is getting deeper and deeper, and it is known that it is coming around behind the abutment of the bridge when it gets that far down. The proper thing to do is to take advantage of that mile and begin to work with the system, in small pieces. In this way 1,000 ft. of work will afford more protection than 5,000 ft. would do at the time of the crisis.

Where tracks skirt rivers and the river gradually or suddenly invades the right of way, reducing it one-half or more by caving, the only remedy is to fill it up, but while doing this ribs can be put into that body of earth in the shape of gabions. Figure 12 shows typical river conditions above a railroad bridge. The method of protection is to put in Gabion B when No. 1 starts, but if No. 1 is completed put in Gabions B and C.

E. L. Loftin,
Chairman of Committee.

DISCUSSION.

The President:—The next report to be considered is the one on embankment protection, of which Mr. Loftin is chairman. The report is not printed. Is Mr. Loftin in the room? If not the secretary will read the report.

The Secretary:—This report has not been arranged in first-class shape. I will read it as it is. We will have it revised before it is sent to the printer.

(The report was read by the secretary.)

The President:—This is a continuation of the report of last year. It is an interesting subject and we would like to hear a lively discussion of it.

Mr. Van Auken:—This is a matter in which I have had some little experience and have made considerable observation. In the early years of my work I was with the United States Engineer Corps, and served on the lower Mississippi, the Arkansas, the Wisconsin, the upper Mississippi and the Missouri rivers. In railroad service I have often found it necessary to protect the embankments at bridge ends and other threatened points from streams of various sizes. There does not seem to be any best way to treat streams of all sizes. If the threatening stream has a rock bottom, or is in a soil that will not wash, there is nothing quite equal to riprap, if stone is to be had. If one has to deal with a stream like the Arkansas or Red, or the larger rivers in an alluvial country, what seems best is the mattress just mentioned. It is very expensive to construct in most streams, as it must be carried to the thalweg of the stream (this is a German word for which we have no English equivalent, and means the center of the deepest thread of the stream,) and it also must be carried both above and below the points where the current strikes the bank. Unless this is done, the current will work around one end, or under the mattress and destroy it.

In 1884 the Mississippi river was attacking the Illinois shore at Eliza Point, just above Cairo, eating it away, the river having narrowed to about 700 feet, the depth at this point being 75 feet. This threatened to leave Cairo ultimately on an island. It was protected by a mattress 120 feet in width, for a distance of 4,563 feet along the bank; also by two small mattresses to strengthen some old work which had been done by a land company. This protection cost $36,010, or about $8.00 per foot of bank. The only repair work necessary at that place since the work was done has been to replace some of the riprap above low water which was damaged by ice. This work was a decided success.

On the opposite side of the river, at Bird's Point, were located the yards of the Cotton Belt and the Iron Mountain railroads. This point was threatened, and was protected at three different times, about 1888, 1897 and 1903. I could find no records of the protection of 1888 save that two coal barges were loaded with stone and sunk to divert the current. In 1897, 5,200 lineal feet of bank was riprapped at a cost of $37,028. In 1903 the so-called David Neale system was used for a distance of 4,700 feet, at a cost of $29,140. In 1904 the U. S. Engineers protected the bank with a mattress some distance above the part protected by the Neale method the year before. In 1905 all of the Neale protection was gone, and all but 400 feet of the riprap. The railroad companies lost two inclines and two yards, although part of the Cotton Belt yard was saved together with round houses, stations, etc. Some valuable farm lands and levees were also lost.

Countless proposals have been made for river control, but none to my knowledge has succeeded. One system tried out on the Missouri river cost over $2,000,000. Even this has been entirely destroyed.

The difficulty in protecting against water is the fluidity of the material we are contending with. It changes its form of attack repeatedly. A body of water fifty feet deep, moving five feet per second, has a vast momentum, and carries with it destruction. A plan which may be safe this year may not be next year, owing to a change in the direction of attack of the water. Lack of following up protection work and strengthening the weak points results in many failures.

The city of Pine Bluff was threatened in 1881 and there were all sorts of outcries. A considerable portion of the town was carried away. It was discovered that the banks could be protected by mattresses weighted with boxes filled with sand. It stopped the

wash at the time, but year by year the boxes warped, the sand filtered out, the boxes floated off at the next rise and within a few years it was necessary to protect the bank again. This time it was done by stone-capped brush dikes, set at an angle of forty degrees to the current. This protected the bank for many years, but the dikes were too close together, eddies formed below each, and in time they were destroyed. Dikes must be so close together that the next dike below will catch the eddy and break it. Some two years ago these dikes were washed out, the banks caved, seven houses were washed into the river, the court house was partly destroyed and the leading hotel threatened. The bank is now protected by fascine mattresses and is probably safe.

In the lesser matters, I presume that all of us here have had to get out of bed at night and help pile in stone to save some threatened point. It is not necessary to speak of that method; the main thing is to get there in time.

Mr. Killam:—Years ago, when I was doing contract work for the government of the Province of New Brunswick, in some places the water carried away the entire embankment, in a heavy storm. The surface was of alluvial soil with gravel underneath. About a thousand feet was washed away in one particular place, and I was asked by the engineer of the department at headquarters to repair it. I leveled off the bottom, laid a brush foundation about twenty feet wide at an angle of forty-five degrees, with the tops of the trees angling down stream, and then there was built on it a sort of timber abutment seven feet from the front and fourteen feet high. The space back of it was then filled with earth and stone, making the embankment the original width; the top surface was given a coating of heavy stone. That was some twenty-seven years ago, and there has never been a dollar expended there since. We have found in such cases that there is nothing equal to soft wood brush, such as spruce and fir, put in at an angle with the stream, and then placing stone upon it.

Where we have culverts through heavy embankments in gravel the undertow of the water at the outlet end washes under and undermines them. In such cases we have put in concrete floors which settled the difficulty. On the banks of some of the rivers at the head of the Bay of Fundy, where the marsh mud and the silt give way, (these creeks along the river are generally very crooked and the tide is very rapid,) we build piers, or jetties as they would more properly be termed, angling with the current around the curve, to break the current in that way. In some cases the jetties would be

undermined and go down but they would be built up again better than ever, and in no case did we ever fail to stop the banks from washing away by taking those precautions. The main thing is to have the foundation put down far enough to prevent washing underneath and undermining it. When the water comes in contact with these jetties it is diverted much after the fashion of earth passing over the mould board in plowing land. In ordinary cases of bank wash the brush covered with stone is effective, and it also prevents washing around piers, abutments, etc. Stone alone will not answer the purpose. Some of the jetties mentioned above, I put in myself, as long ago as 1868 or 1869, and they are still in service.

Mr. Penwell:—I want to ask Mr. Killam if he used evergreens in that work.

Mr. Killam:—Yes sir.

Mr. Penwell:—Where we cannot get evergreens would you think of using common hardwood brush?

Mr. Killam:—I think that the hardwood brush alone will not answer, but in some cases we have mixed a little hardwood brush with the evergreens and I don't know but that in some cases it is preferable to do so.

Mr. Staten:—Some may be surprised to know that slate is about as good as anything to prevent wash. There are a number of slate quarries on our road where we can procure waste and broken slate at little cost. While it would not go far toward preventing a wash in the Mississippi river, it does very well along creeks or small rivers. We simply throw it down the bank, and after a little sediment gets into it that acts as a binder and the water will never carry it away. If washing undermines it and it settles, that fact will not matter, for it will not go far. We had a great many places where the water washed away the sides of embankments, often making it quite serious, but we deposited a lot of this slate there and it put an end to the trouble. It has been there for years. Grass and weeds have grown up through it, making a perfect mesh, and it withstands the wash perfectly. We use it also around abutments and piers where it affords most excellent protection.

The President:—I would like to hear from some of these newer members. Unfortunately I do not know their names. As a rule when they get out of the convention hall they can tell us all about it, but they do not feel free in expressing themselves in the convention.

Mr. Penwell:—I would like to hear from Mr. Loftin on this subject.

Mr. Loftin:—I have nothing further to say now I believe. My work is in the secretary's hands. I will say a few words, however, concerning the work in connection with the making up of the report. The committee expected quite a good deal of outside assistance, and had the promise of it, but in the end we received very little. On that account the report is not what it should be; besides, it was sent in too late for the advance copies. The fault is probably due to my holding on to the report until the last moment, with the expectation of getting something additional, but we did not get it. I should have forwarded it earlier. I am sorry it was sent in so late.

The President:—The report is a valubale addition to that of last year. As stated by Mr. Van Auken, a good deal depends upon the character of the soil which makes up the banks and the bed of the stream.

Mr. Penwell:—My object in calling for Mr. Loftin was not in regard to his report, but I know that he has had considerable experience in connection with this subject on his line, and that is what I sought to bring out in the discussion.

The President:—Mr. Penwell called attention to the fact, Mr. Loftin, that you have had some experience in regard to embankment protection which he wanted you to relate. Was your experience fully given in the report?

Mr. Loftin:—I have not given much of my experience in this report. Most of that was given in last year's report. To devise a system that will suit conditions everywhere is impracticable. I might say that this is a poor subject to gather information on. People do not like to take hold of it. I had quite a time getting any information at all. There are many subjects where data for them are on file and accessible at all times, but washouts and the protection of embankments is something that comes to us no two times alike, and when they do come they come quickly, so that it is pretty difficult to lay down any fixed rule that will apply to even a few cases of embankment protection. That is my experience.

We have a report from the Mississippi River Commission which goes pretty well into details. It shows the process of doing this work and what it costs. This is based on a mattress 255 feet wide and 900 feet long. They had just sunk a mattress opposite Vicksburg of the same dimensions when I left to come here. Down with us washouts are a little different from the washouts up in this country. We have the Mississippi river to contend with. I have seen

the Mississippi river 75 miles wide right over the track of the Vicksburg, Shreveport & Pacific Ry., with the exception of four miles. When you get up against conditions of that kind, you have something to do.

The President:—My early experience was confined to the northern part of Wisconsin where there are no alluvial deposits but simply hard material. A few years ago, after I had been transferred to Iowa I was suddenly confronted with the threatened cutting away of a bank of the Missouri river near Sioux City, and I suggested driving some piles to protect the bank. I think I would have made a mistake if I had done so, do you not, Mr. Van Auken?

Mr. Van Auken:—I think you would. I will refer to one piece of work done on the Missouri river some time between 1878 and 1883, by the Chicago, Burlington & Quincy R. R., near Plattsmouth, Neb. They reclaimed their Plattsmouth yard from the Missouri river. As I recall it, there was a stone quarry some miles up the river that they secured. They got some scows that were fifty or sixty feet long and drove a row of piles that were slightly closer together than the length of the scows, along the outside of what they wanted to reclaim for this yard. They would load these scows with stone at the quarry and drop them down and tie them to these piles and then just throw the stone off on the inside of the scow. They built the work up in this way to a little above the surface at low water, just to such height as they could easily throw the stone off the scows, and the next high water filled the space full of silt behind those stones. They soon had it up to low-water grade. They continued to build it up and the next high water filled it up further and they merely had to build enough above that to make it safely above high water. They could not get back of the bluffs. Anybody who knows about the bluffs along the Missouri river knows what that means. I was not connected with that work, but any one who is interested can find it described in one of the numbers of Van Nostrand's Magazine, between 1879 and 1884.

The President:—I know that the Chicago & Northwestern Ry. is spending annually all the way from $50,000 to $75,000 for the work of protection along the Missouri river at Blair. Sioux City was never threatened until about four years ago. I mentioned the beginning of my experience in Iowa, but before the work was completed I was relieved of that territory, to my great regret, and my successor completed the work. There has been a great deal of that kind of work done also at Pierre, So. Dak., where the new bridge

was built across the river by the Northwestern on the Pierre and Rapid City line.

I have taken enough interest in that work at Sioux City to know that it was entirely successful. The railroad was constructed in a side-hill cut, where the hill dropped closely to the river, and it began to eat out the bank and was threatening the main line. Action was taken right away, and there hasn't been any trouble since.

If there is any one else who would like to speak on the subject, we will be glad to hear from him. We have brought out some information, as a result of the discussion of this report, that is of considerable interest.

Mr. Sattley:—I would like to ask if the report gives the price of doing work, per running foot or otherwise?

Mr. Loftin:—Yes, I have given prices for all of this work.

I failed to state that down in our country we do not have stone for emergency protection work, as they have in this part of the country. About the only thing we have down there for protecting embankments along the track is slag, which we get from Alabama, and that is some distance away. While it is not very large in size, it protects embankments pretty well when applied six inches or more in thickness. Bermuda grass soon takes root and grows right through it. Bermuda grass also grows through cinders, and in fact will grow anywhere, almost, and forms a good mat and makes a good protection,—better than anyone would at first suppose.

Mr. Van Auken:—(Replying to question of Mr. Sattley.) That is a question you cannot answer for all places. The cost of the mattress is dependent upon the cost of the brush and the stone, which varies greatly, according to the supply and the accessibility of the same. Then the width of the stream determines the width of the mattress. As I before stated, one must go from the low-water edge of the bank to the central thread of the deepest part of the river. The Missouri river, at Bismarck, is a very different stream from the same river at Kansas City, and the latter is very different from the Mississippi at Vicksburg. Mr. Loftin's report gives the price per lineal foot at the latter place. At Cairo the price might be half that, and at Sioux City one-fourth. Then, when there is much work being done, there may be a shortage of brush. The Mississippi River Commission has made some mattresses by using cypress boards. In general, the cost will depend upon the cost of stone, cost of brush and size of mat.

Mr. Sattley:—Is not this work done by contract, sometimes?

Mr. Van Auken:—Yes sir.

Mr. Sattley:—Are there any statistics on that question? If so where can they be found?

Mr. Van Auken:—The reports of the Mississippi River Commission give each year the cost of such work done under the supervision of that organization. The U. S. engineer officers in charge of the Mississippi river, from St. Paul to Grafton, and from Grafton to Cairo, and those in charge of the Missouri each give such costs. The Chicago & Alton Ry. had some work done near its bridge across the Missouri, and the costs of that are given in a report made by W. R. DeWitt, in Engineering News, in 1904. Camp's book on track goes into the details of such work, including the division of the labor, and the cost.

Mr. Loftin:—Getting back to the fascine mattress; I have given the cost of brush, the specifications for it, size, kind and number of cables with which it is woven and the spacing of them. This kind of river protection deals only indirectly with the subject and we did not go into it very far, for we were not certain whether or not it would be acceptable as a part of the report.

River protection is a large undertaking and a pretty big outfit is necessary for that kind of work. A government plant for such work I should say would cost anywhere from $200,000 to $350,000. The cost of the upkeep of such a plant would also be considerable, of course. We have tracks along the banks of the Mississippi river where there is an alluvial soil which may be 100 feet deep, I am not sure about that, but anyway, when it starts to wash we have to get after it to check it. At Vicksburg as I stated in the report of last year, the river changed its channel in 1876, so that it left Vicksburg entirely away from the river, and the government has spent a great sum of money, I don't know just how much, but a great deal of money, in changing the direction of the Yazoo river to bring it back in front of Vicksburg in order to restore navigation and put the city on the water front again. If I could have found Mr. Van Auken while I was engaged in the report I would have had a good, strong supporter.

The President:—It is a good thing that we have found him here.

Mr. Loftin:—Yes, I am glad to admit it. I think I will have to hunt him up and play neighbors with him.

The President:—Mr. Van Auken, I have in my mind that the Burlington Railroad has a special department in charge of river protection.

Mr. Van Auken:—During the time Mr. Byers was Chief En-

gineer of Maintenance of Way of the Missouri Pacific Ry., he had an officer called " Engineer of River Protection."

The President:—That must have been it.

Mr. Van Auken:—The Chicago & Alton R. R. protected a considerable stretch up the Missouri river with these fascine mattresses, and after they had done that they had another stretch threatened; but owing to the great cost of mattresses they protected that with spur dikes. The dikes were built by driving in piling and then fastening a rail to it. I think it was bolted or wired to it. There were two rows of piles and these rails were bolted to them and they were braced across between the rows of piling. Then at the upper edge there were saplings and pieces of two by fours, I think, spiked up and down to these rails that I have mentioned. This ran nearly at right angles to the bank, out into the stream. This arrangement created a bar at these points, as it is bound to do if the dikes are built close enough together. They built a bar outside of the bank, and by that protected the bank. The trouble with these dikes is that they are short lived; they require constant attention every year, and probably have to be rebuilt once in seven or eight years; but they are much cheaper in first cost, than the fascine mattresses. I wish to say that where the Rock Island crosses the river they have resorted to the same manner of protecting their banks, by building dikes and filling them in with stone. Of course the current is not very swift there, but these banks fill up and make land themselves. The scheme works all right where there is a solid bottom; but if one ever tried that on the Mississippi river he would find that the stone would disappear and have but little effect. At Bird's Point I took some soundings three years after some such work had been done and while our line was 75 feet long the lead disclosed no signs of stone. Stone simply will have no effect in such places.

The President:—Gentlemen what will you do with the report?

Mr. J. H. Markley:—I move that the report be received and the committee discharged with the thanks of the association.

The motion was seconded and carried.

Note: This Association received the title—American Railway Bridge and Building Association—at the 18th annual convention at Washington, D. C., October, 1908. Prior to that time it was called —Association of Railway Superintendents of Bridges and Buildings.

LIST OF ANNUAL CONVENTIONS.

No.	Place.	Date.	Membership.
1	St. Louis, Mo.,	Sept. 25, 1891.	60
2	Cincinnati, Ohio,	Oct. 18-19, 1892.	112
3	Philadelphia, Pa.,	Oct. 17-19, 1893	128
4	Kansas City, Mo.,	Oct. 16-18, 1894	115
5	New Orleans, La.,	Oct. 15-16, 1895	122
6	Chicago, Ill.,	Oct. 20-22, 1896	140
7	Denver, Col.,	Oct. 19-21, 1897	127
8	Richmond, Va.,	Oct. 18-19, 1898	148
9	Detroit, Mich.,	Oct. 17-18, 1899	148
10	St. Louis, Mo.,	Oct. 16-18, 1900	143
11	Atlanta, Ga.,	Oct. 15-17, 1901	171
12	Minneapolis, Minn.,	Oct. 21-23, 1902	195
13	Quebec, Canada,	Oct. 20-22, 1903	223
14	Chicago, Ill.,	Oct. 18-20, 1904	293
15	Pittsburg, Pa.,	Oct. 17-19, 1905	313
16	Boston, Mass.,	Oct. 16-18, 1906	340
17	Milwaukee, Wis.,	Oct. 15-17, 1907	341
18	Washington, D. C.,	Oct. 20-22, 1908	368
19	Jacksonville, Fla.,	Oct. 19-21, 1909	393
20	Denver, Colo.,	Oct. 18-20, 1910	428
21	St. Louis, Mo.,	Oct. 17-19, 1911	499

	1891-2.	1892-3.	1893-4.	1894-5.
President	O. J. Travis...	H. M. Hall......	J. E. Wallace....	Geo. W. Andrews.
1st. V.-Pres. .	H. M. Hall.....	J. E. Wallace....	Geo. W. Andrews..	W. A. McGonagle.
2nd. V.-Pres.	J. B. Mitchell..	G. W. Hinman..	W. A. McGonagle.	L. K. Spafford.
3rd. V.-Pres.	James Stannard.	N. W. Thompsor	L. K. Spafford....	James Stannard.
4th. V.-Pres. .	G. W. Hinman..	C. E. Fuller....	E. D. Hines......	Walter G. Berg.
Secretary	C. W. Gooch...	S. F. Patterson..	S. F. Patterson....	S. F. Patterson.
Treasurer	George M. Reid.	George M. Reid..	George M. Reid..	George M. Reid.
Executive Members .	W. R. Damon..	G. W. Andrews..	Q. McNab	James Stannard.
	G. W. Markley.	J. M. Staten....	A. S. Markley....	James H. Travis.
	W. A. McGonagle	J. M. Caldwell..	Floyd Ingram.....	J. H. Cummin.
	G. W. McGehee.	Q. McNab.......	James Stannard ..	R. M. Peck.
	G. W. Turner...	Floyd Ingram...	James H. Travis ..	J. L. White.
	J. E. Wallace...	A. S. Markley...	J. H. Cummin	A. Shane.

	1895-6.	1896-7.	1897-8.	1898-9.
President	W. A. McGonagle	James Stannard..	Walter G. Berg....	J. H. Cummin.
1st. V.-Pres. .	L. K. Spafford.	Walter G. Berg..	J. H. Cummin....	A. S. Markley.
2nd. V.-Pres.	James Stannard.	J. H. Cummin...	A. S. Markley....	C. C. Mallard.
3rd. V.-Pres.	Walter G. Berg.	A. S. Markley...	G. W. Hinman....	W. A. Rogers.
4th. V.-Pres. .	J. H. Cummin.	R. M. Peck....	C. C. Mallard.....	J. M. Staten.
Secretary	S. F. Patterson.	S. F. Patterson..	S. F. Patterson....	S. F. Patterson.
Treasurer	George M. Reid.	N. W. Thompsor	N. W. Thompson..	N. W. Thompson.
Executive Members .	R. M. Peck....	W. O. Eggleston	G. J. Bishop......	Wm. S. Danes.
	J. L. White...	W. M. Noon....	C. P. Austin......	J. H. Markley.
	A. Shane	J. M. Staten....	M. Riney	W. O. Eggleston.
	A. S. Markley..	G. J. Bishop.....	Wm. S. Danes....	R. L. Heflin.
	W. M. Noon...	C. P. Austin....	J. H. Markley....	F. W. Tanner.
	J. M. Staten...	M. Riney	W. O. Eggleston..	A. Zimmerman.

	1899-1900.	1900-1901.	1901-1902.	1902-1903.
President	Aaron S. Markley	W. A. Rogers....	W. S. Danes.....	B. F. Pickering.
1st. V.-Pres. .	W. A. Rogers...	W. S. Danes.....	B. F. Pickering..	C. C. Mallard.
2nd. V.-Pres.	J. M. Staten....	B. F. Pickering..	A. Shane	A. Shane.
3rd. V.-Pres.	Wm. S. Danes...	A. Shane........	A. Zimmerman ..	A. Zimmerman.
4th. V.-Pres. .	B. F. Pickering..	A. Zimmerman ..	C. C. Mallard....	A. Montzheimer.
Secretary	S. F. Patterson..	S. F. Patterson..	S. F. Patterson..	S. F. Patterson.
Treasurer	N. W. Thompson	N. W. Thompson.	N. W. Thompson.	N. W. Thompson.
Executive Members .	T. M. Strain....	T. M. Strain.....	A. Montzheimer..	W. E. Smith.
	R. L. Heflin....	H. D. Cleaveland.	W. E. Smith.....	A. W. Merrick.
	F. W. Tanner...	F. W. Tanner...	A. W. Merrick...	C. P. Austin.
	A. Zimmerman...	A. Montzheimer.	C. P. Austin.....	C. A. Lichty.
	H. D. Cleaveland	W. E. Smith....	C. A. Lichty.....	W. O. Eggleston.
	A. Montzheimer.	A. W. Merrick...	W. O. Eggleston.	J. H. Markley.

	1903-1904.	1904-1905.	1905-1906.	1906-1907.
President	A. Montzheimer..	C. A. Lichty...	J. B. Sheldon....	J. H. Markley.
1st. V.-Pres. .	A. Shane	J. B. Sheldon..	J. H. Markley....	R. H. Reid.
2nd. V.-Pres.	C. A. Lichty....	J. H. Markley..	R. H. Reid.......	J. P. Canty.
3rd. V.-Pres.	J. B. Sheldon...	R. H. Reid.....	R. C. Sattley....	H. Rettinghouse.
4th. V.-Pres. .	J. H. Markley...	R. C. Sattley...	J. P. Canty......	F. E. Schall.
Secretary	S. F. Patterson..	S. F. Patterson..	S. F. Patterson..	S. F. Patterson.
Treasurer	C. P. Austin....	C. P. Austin....	C. P. Austin.....	C. P. Austin.
Executive Members .	R. H. Reid......	W. O. Eggleston	H. Rettinghouse .	W. O. Eggleston.
	W. O. Eggleston	A. E. Killam....	A. E. Killam.....	A. E. Killam.
	A. E. Killam....	H. Rettinghouse.	J. S. Lemond.....	J. S. Lemond.
	R. C. Sattley....	J. S. Lemond....	C. W. Richey....	C. W. Richey.
	H. Rettinghouse..	W. H. Finley..	H. H. Eggleston.	H. H. Eggleston.
	J. S. Lemond....	C. W. Richey...	F. E. Schall.....	B. J. Sweatt.

	1907-1908.	1908-1909.	1909-1910.	1910-1911.
President	R. H. Reid......	J. P. Canty	J. S. Lemond...	H. Rettinghouse
1st. V.-Pres. .	J. P. Canty.....	H. Rettinghouse..	H. Rettinghouse..	F. E. Schall
2nd. V.-Pres.	H. Rettinghouse..	F. E. Schall.....	F. E. Schall....	A. E. Killam
3rd. V.-Pres.	F. E. Schall	J. S. Lemond....	A. E. Killam...	J. N. Penwell
4th. V.-Pres. .	W. O. Eggleston.	A. E. Killam....	J. N. Penwell..	L. D. Hadwen ..
Secretary	S. F. Patterson..	S. F. Patterson..	C. A. Lichty....	C. A. Lichty
Treasurer	C. P. Austin....	C. P. Austin....	J. P. Canty....	J. P. Canty
Executive Members .	A. E. Killam....	J. N. Penwell....	W. Beahan	T. J. Fullem
	J. S Lemond.....	Willard Beahan ..	F. B. Scheetz .	G. Aldrich
	C. W. Richey....	F. B. Scheetz...	L. D. Hadwen ..	P. Swenson
	T. S. Leake......	W. H. Finley...	T. J. Fullem....	G. W. Rear
	W. H. Finley....	L. D. Hadwen ..	G. Aldrich......	W. O. Eggleston.
	J. N. Penwell....	T. J. Fullem....	P. Swenson.....	W. F. Steffens

	1911-1912.			
President	F. E. Schall			
1st. V.-Pres. .	A. E. Killam ...			
2nd. V.-Pres.	J. N. Penwell ...			
3rd. V.-Pres.	L. D. Hadwen ..			
4th. V.-Pres. .	T. J. Fullem			
Secretary	C. A. Lichty			
Treasurer	J. P. Canty			
Executive Members .	G. Aldrich			
	P. Swenson			
	G. W. Rear			
	W. F. Steffens ..			
	E. B. Ashby			
	W. O. Eggleston			

CONSTITUTION

ARTICLE I.

NAME.

SECTION 1. This association shall be known as the American Railway Bridge & Building Association.

ARTICLE II.

OBJECT.

SECTION 1. The object of this association shall be the advancement of knowledge pertaining to the principles, design, construction and maintenance of railway bridges, buildings and other structures, by investigation, reports and discussion of the experience of its members and others, and to provide a means of exchange of ideas, so that bridge and building practice may be systematized and improved.

SECT. 2. The association shall neither endorse nor recommend any particular patents, materials or supplies, but individual opinions of members may be expressed and appear in the proceedings.

ARTICLE III.

MEMBERSHIP.

SECTION 1. The membership of this association shall consist of two classes, active and life members.

SECT. 2. A person who is actively engaged in railway service in a responsible position, in charge of work connected with the construction or maintenance of railway bridges and buildings or other structures, or a professor of engineering, government timber expert, or railroad architect shall be eligible for active membership upon application to the secretary, and the payment of three dollars membership fee, and two dollars for one year's dues.

SECT. 3. Any member elected a life member of this association shall have all the privileges of an active member, but shall not be required to pay annual dues. To be elected a life member he must have been a member of the association at least five years and before being elected must have been pensioned by the railway company for which he worked or shall have retired from active railway service.

SECT. 4. Any member guilty of dishonorable conduct, or conduct unbecoming a railroad official and member of this association, or who shall refuse to obey the chairman, or rules, may be expelled by a two-thirds vote of the members present.

SECT. 5. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled.

ARTICLE IV.

OFFICERS.

SECTION 1. The officers of this association shall be a president, four vice-presidents, a secretary, a treasurer, and six executive members.

SECT. 2. The executive members, together with the president, vice-presidents, secretary and treasurer, shall constitute the executive committee.

SECT. 3. Past presidents of this association who continue to be members shall be entitled to be present at all meetings of the executive committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past-presidents shall not have a right to vote, nor shall their presence be requisite in order to constitute a quorum.

SECT. 4. Vacancies in any office for the unexpired term shall be filled by the executive committee without unnecessary delay.

ARTICLE V.

EXECUTIVE COMMITTEE.

SECTION 1. The executive committee shall exercise a general supervision over the financial interests of the association, assess the amount of annual and other dues, call, prepare for and conduct general or special meetings, make all necessary purchases and contracts required to conduct the general business of the association, but shall not have the power to render the association liable for any debt beyond the amount then in the treasurer's hands not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the association.

SECT. 2. Two thirds of the members of the executive committee may call special meetings, thirty days' notice being given members by mail.

SECT. 3. Five members of the executive committee shall constitute a quorum for the transaction of business.

ARTICLE VI.

ELECTION OF OFFICERS AND TENURE OF OFFICE.

SECTION 1. The officers, excepting as otherwise provided, shall be elected at the regular meeting of the association, held on the third Tuesday in October of each year, and the election shall not be postponed except by unanimous consent.

SECT. 2. The president and treasurer shall be elected by ballot by a majority of votes cast, and shall hold office for one year or until successors are elected. No member in arrears shall be eligible for office, and the president shall not be eligible for reelection.

Vice-Presidents and Executive Members.

SECT. 3. The vice-presidents shall hold office for one year and executive members for two years; four vice-presidents and three executive members to be elected each year; all officers herein named to hold office until successors are chosen.

SECT. 4. In the election of vice-presidents, each one shall be elected by a majority vote. Executive members shall be elected in the same way, all voting to be by written ballots.

Secretary.

SECT. 5. A secretary shall be elected by a majority of the votes of the members present at the annual meeting. The term of office of the secretary shall be for one year, unless terminated sooner by action of the executive committee, two thirds of whom may remove the secretary at any time. His compensation shall be fixed by a majority of the executive committee. The secretary shall also be secretary of the executive committee.

Treasurer.

SECT. 6. The treasurer shall be required to give bond in an amount to be fixed by the majority of the executive committee.

ARTICLE VII.

COMMITTEES.

Nominating Committee.

SECTION 1. After each annual meeting the president shall appoint a committee of five members, not officers of the association, of whom two at least shall be past presidents, and two of whom shall have served on the committee the previous year. They shall prepare a list of names of nominees for officers to be voted on at the next annual convention, agreeable to Article VI. of this constitution, said list to be read at the first session of the second day of said convention. Nothing in this section shall be construed to prevent any member making nominations.

Auditing Committee.

SECT. 2. At the first session of each annual meeting there shall be appointed by the president an auditing committee of three members, not officers of the association, whose duty it shall be to examine the accounts and vouchers of the secretary and treasurer and certify as to the correctness of their accounts. Acceptance of this committee's report will be regarded as the discharge of the committee.

Committee on Subjects for Discussion.

SECT. 3. At the annual meeting there shall be appointed, by the president, a committee, whose duty it shall be to prepare and report subjects for investigation and discussion at the next annual meeting. It shall be the duty of the committee to receive from members questions for discussion during the time set apart for that purpose. This committee shall decide whether such questions are suitable ones for discussion, and if approved, report them to the association.

Committees on Investigation.

SECT. 4. When the committee on subjects has reported and the association approved of the same, the president shall appoint special committees to investigate and report on said subjects and he may appoint a special committee to investigate and report on any subject of which a majority of members present may approve.

Publication Committee.

SECT. 5. After each annual meeting the executive committee shall appoint a publication committee of three active members whose duty it shall be to supervise the publication of the proceedings. The assignment of this committee shall be such that at least one member shall have served on the committee during the previous year. The publication committee will report to the president and perform their duties under his supervision.

ARTICLE VIII.

ANNUAL DUES.

SECTION 1. Every active member shall pay to the secretary three dollars membership fee and shall also pay two dollars per year in advance to defray the necessary expenses of the association. No member being one year in arrears for dues shall be entitled to vote at any election, and any member one year in arrears may be stricken from the list of members at the discretion of the executive committee.

ARTICLE IX.

AMENDMENTS.

SECTION 1. This constitution may be amended at any regular meeting by a two thirds vote of members present, provided that a written notice of the proposed amendment, or amendments, has been given at least sixty days previous to said regular meeting.

BY-LAWS

TIME OF MEETING.

1. The regular meeting of this association shall be held annually on the third Tuesday in October.

HOUR OF MEETING.

2. The regular hour of meeting shall be at 10 o'clock a. m., unless changed by order of the presiding officer.

PLACE OF MEETING.

3. The cities or places for holding the annual convention may be proposed at any regular meeting of the association before the final adjournment. The places proposed shall be submitted to a ballot vote of the members of the association, the city or place receiving a majority of all the votes cast to be declared the place of the next annual meeting; but if no place received a majority of all votes, then the place receiving the lowest number of votes shall be dropped on each subsequent ballot until a place is chosen.

QUORUM.

4. At the regular meeting of the association, fifteen or more members shall constitute a quorum.

ORDER OF BUSINESS.

5. 1st—Calling of roll.
   2nd—Reading minutes of last meeting.
   3rd—Admission of new members.
   4th—President's address.
   5th—Reports of secretary and treasurer.
   6th—Payment of annual dues.
   7th—Appointment of committees.
   8th—Reports of committees.
   9th—Unfinished business.
   10th—New business.
   11th—Reading and discussion of questions propounded by members.
   12th—Miscellaneous business.
   13th—Election of officers.
   14th—Adjournment.

(Report of nominating committee to be read at first session of second day.)

DUTIES OF OFFICERS.

6. The president shall have general supervision of the affairs of the association. He shall preside at all meetings of the asso-

ciation, and of the executive committee, at which he may be present; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. He shall, with the secretary, sign all contracts or other written obligations of the association which have been approved by the executive committee.

At the annual meeting the president shall present a report containing a statement of the general condition of the association, and an address.

7. The vice-presidents in order of seniority shall preside at meetings in the absence of the president, and discharge his duties in case of a vacancy in his office.

8. It shall be the duty of the secretary to keep a correct record of proceedings of all meetings of this association; to keep correct all accounts between this association and its members; collect all moneys due the association, and pay the same over to the treasurer and take his receipt therefor, and to perform such other duties as the association may require.

9. The treasurer shall receive all moneys and deposit the same in the name of the association and shall receipt to the secretary therefor. He shall invest all funds not needed for current disbursements as shall be ordered by the executive committee. He shall pay all bills, when properly certified and approved by the president, and make such reports as may be called for by the executive committee.

DECISIONS.

10. The votes of a majority of members present shall decide any question, motion or resolution which shall be brought before the association, unless otherwise provided.

DISCUSSIONS.

11. All discussions shall be governed by Robert's rules of order.

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Trautman, J. J.
Van Der Hoek, J.
Wallace, I. E.
Walden, W. D.
Welch, E. T.
Wood, W. B.
Worden, C. G.

MEMBERSHIP AND MILEAGE OF RAILWAYS REPRESENTED.

Name of Road and Membership.	Members.	Mileage.
Algoma Central & Hudson Bay Ry.	1	116
R. S. McCormick, Sault Ste. Marie, Ont.		
Arizona Eastern R. R.	1	355
C. C. Mallard, Globe, Ariz.		
Atchison, Topeka & Santa Fé Ry.	4	5,604
E. McCann, Wellington, Kan.		
John L. Talbott, Pueblo, Col.		
J. M. Wells, Chillicothe, Ill.		
M. R. Williams, Las Vegas, N. M.		
Atchison, Topeka & Santa Fé Ry. (Coast Lines)	5	2,022
E. E. Ball, Winslow, Ariz.		
J. F. Parker, San Bernardino, Cal.		
V. C. Proctor, Winslow, Ariz.		
D. A. Shope, Fresno, Cal.		
J. W. Wood, Needles, Cal.		
Atlanta & West Point R. R. and W. Ry. of Ala.	2	225
O. T. Nelson, Montgomery, Ala.		
J. C. Williams, Opelika, Ala.		
Atlantic Coast Line R. R.	1	4,361
J. W. Salisbury, Port Tampa, Fla.		
Baltimore & Ohio R. R. and B. & O. S. W. R. R.	10	4,738
G. W. Andrews, Baltimore, Md.		
W. M. Clark, Pittsburgh, Pa.		
W. T. Hopke, Grafton, W. Va.		
J. T. McIlwain, Akron, O.		
W. S. Schenck, Connellsville, Pa.		
W. F. Strouse, Baltimore, Md.		
S. C. Tanner, Baltimore, Md.		
D. B. Taylor, Garrett, Ind.		
F. A. Taylor, Cumberland, Md.		
E. C. Zinsmeister, Zanesville, O.		
Baltimore & Ohio, Chicago Terminal R. R.	1	289
H. H. Eggleston, Chicago.		
Bangor & Aroostook R. R.	2	628
W. E. Alexander, Houlton, Me.		
M. Burpee, Houlton, Me.		
Bessemer & Lake Erie R. R.	1	210
H. D. Cleaveland, Greenville, Pa.		

Name of Road and Membership.	Members.	Mileage
Boston & Albany R. R.	1	392
W. F. Steffens, Boston, Mass.		
Boston & Maine R. R.	14	2,288
Cyrus P. Austin, Medford, Mass.		
C. C. Battey, Concord, N. H.		
J. P. Canty, Fitchburg, Mass.		
John Ewart, Boston, Mass.		
Andrew B. Hubbard, Boston, Mass.		
F. J. Leavitt, Salem, Mass.		
William A. Lydston, Salem, Mass.		
John Marsh, Lawrence, Mass.		
Albert Mountfort, Nashua, N. H.		
A. A. Page, Concord, N. H.		
S. F. Patterson, Concord, N. H.		
B. F. Pickering, Salem, Mass.		
Fred C. Rand, Boston, Mass.		
F. A. Sherwin, St. Johnsbury, Vt.		
Brazil Ry.,	1	10,000
A. M. Dodd, Sao Paulo, Brazil, S. A.		
Canadian Pacific Ry.	3	10,480
F. P. Gutelius, Montreal, P. Q.		
Frank Lee, Winnipeg, Man.		
D. A. McRae, Cranbrook, B. C.		
Carolina & Northwestern Ry.	1	133
J. W. Fletcher, Jr., Chester, S. C.		
Central of Georgia Ry.	1	1,916
H. C. McKee, Macon, Ga.		
Central Vermont Ry.	4	536
J. E. Cole, St. Albans, Vt.		
C. Donaldson, Waterbury, Vt.		
C. F. Flint, St. Albans, Vt.		
H. E. Holmes, New London, Conn.		
Chesapeake & Ohio Ry.	5	2,027
F. M. Griffith, Covington, Ky.		
Oscar L. Grover, Richmond, Va.		
C. E. Powell, Hinton, W. Va.		
J. M. Staten, Richmond, Va.		
C. W. Vandegrift, Ronceverte, W. Va.		
Chicago & Eastern Illinois R. R.	1	1,266
A. S. Markley, Danville, Ill.		
Chicago & North Western Ry.	30	8,101
L. J. Anderson, Escanaba, Mich.		
H. Bender, Eagle Grove, Ia.		
F. L. Burrell, Fremont, Neb.		
F. M. Case, Belle Plaine, Ia.		
O. F. Dalstrom, Chicago.		
H. H. Decker, Winona, Minn.		
T. H. Durfee, Huron, S. D.		
W. H. Finley, Chicago, Ill.		
M. J. Flynn, Chicago, Ill.		
G. W. Hand, Chicago, Ill.		
John Hunciker, Chicago, Ill.		
Lee Jutton, Chicago, Ill.		

Name of Road and Membership.	Members.	Mileage
Chicago & North Western Ry. Continued.		
C. A. Lichty, Chicago, Ill.		
George Loughnane, Escanaba, Mich.		
W. T. Main, Chicago, Ill.		
C. A. Marcy, Chicago, Ill.		
A. W. Merrick, Boone, Ia.		
W. F. Meyers, Belle Plaine, Ia.		
J. D. Moen, Boone, Ia.		
J. A. S. Redfield, Sioux City, Iowa.		
H. Rettinghouse, Boone, Ia.		
R. W. Richardson, Sioux City, Ia.		
M. Riney, Baraboo, Wis.		
J. S. Robinson, Chicago, Ill.		
D. Rounseville, Antigo, Wis.		
A. R. Shedd, Chicago, Ill.		
Wm. Spencer, Chadron, Nebr.		
W. M. Sweeney, Green Bay, Wis.		
H. M. Trippe, Chicago, Ill.		
J. B. White, Boone, Ia.		
Chicago Burlington & Quincy R. R.	3	9,075
Geo. Fenney, McCook, Neb.		
W. Hurst, St. Joseph, Mo.		
C. J. Scribner, Chicago.		
Chicago Great Western R. R.	1	1,492
H. A. Elwell, Clarion, Ia.		
Chicago, Indianapolis & Louisville Ry.	1	578
J. M. Caldwell, Lafayette, Ind.		
Chicago, Milwaukee & St. Paul Ry.	14	9,082
(and C. M. & P. S. Ry.)		
E. J. Auge, Wells, Minn.		
A. G. Bennett, Minneapolis, Minn.		
H. R. Drum, Chamberlain, S. D.		
L. D. Hadwen, Chicago, Ill.		
F. E. King, Milwaukee, Wis.		
N. H. LaFountain, Chicago, Ill.		
C. F. Loweth, Chicago, Ill.		
E. S. Meloy. Chicago.		
Edw. Murray, Miles City, Mont.		
William Ross, Milbank, S. D.		
Fred E. Weise, Chicago, Ill.		
William E. Wood, Chicago, Ill.		
A. A. Wolf, Milwaukee, Wis.		
A. Yappen, Chicago, Ill.		
Chicago, Rock Island & Pacific Ry.	6	7,551
McClellan Bishop, El Reno. Okla.		
C. H. Eggers, Little Rock, Ark.		
E. R. Floren, Chicago.		
M. E. Gumphrey, Eldon, Mo.		
W. V. Parker, Amarillo, Tex.		
R. C. Sattley. Chicago.		
Chicago, St. Paul, Minneapolis & Omaha Ry.	4	1,744
G. Larson, Hudson, Wis.		
A. G. Rask, Spooner, Wis.		
Aug. Ruge, Mankato, Minn.		
W. B. Rogers, Emerson, Neb.		

Name of Road and Membership.	Members.	Mileage
Chicago, Terre Haute & Southeastern Ry.	1	351
J. Dupree, Crete, Ill.		
J. O. Jewell, Terre Haute, Ind.		
Cincinnati, Hamilton & Dayton Ry.	1	1,015
I. F. White, Indianapolis, Ind.		
Cincinnati Northern R. R.	1	236
J. M. Wilkinson, Van Wert, O.		
Colorado & Southern Ry.	5	1,250
R. W. Beeson, Trinidad, Colo.		
C. W. Fellows, Denver, Colo.		
Harry James, Denver, Colo.		
A. W. Pauba, Denver, Colo.		
W. T. Powell, Denver, Colo.		
Columbia, Newberry & Laurens R. R.	1	75
A. P. Rice, Columbia, S. C.		
Concho, San Saba & Llano Valley R. R.	1	61
K. S. Hull, Temple, Tex.		
Copper Range R. R.	1	128
A. Giesing, Houghton, Mich.		
Delaware, Lackawanna & Western R. R.,	6	957
F. J. Arnold, Scranton, Pa.		
G. E. Boyd, Scranton, Pa.		
E. Cahill, Binghamton, N. Y.		
A. McQueen, Binghamton, N. Y.		
J. E. Ranney, Buffalo, N. Y.		
Jas. Skeoch, Dunmore, Pa.		
Denver & Rio Grande R. R.	6	2,598
G. W. Kinney, Salt Lake City.		
A. Ridgway, Denver, Colo.		
A. C. Snyder, Glenwood Springs, Colo.		
H. Taylor, Alamosa, Colo.		
C. S. Thompson, Denver, Colo.		
Jas. Vaughan, Salida, Colo.		
Duluth & Iron Range R. R.	2	168
W. A. Clark, Duluth, Minn.		
B. T. McIver, Two Harbors, Minn.		
Duluth, Missabe & Northern Ry.	1	297
W. A. McGonagle, Duluth, Minn.		
Duluth, South Shore & Atlantic Ry.	1	586
W. M. Noon, Marquette, Mich.		
Elgin, Joliet & Eastern Ry.	3	770
G. H. Jennings, Joliet, Ill.		
A. Montzheimer, Joliet, Ill.		
C. Thompson, Gary, Ind.		
El Paso & Southwestern System	1	903
Bailey J. Mustain, El Paso, Tex.		
Erie R. R. (and Chicago & Erie)	8	2,665
O. F. Barnes, Susquehanna, Pa.		
W. O. Eggleston, Huntington, Ind.		
A. J. Horth, Meadville, Pa.		

Name of Road and Membership.	Members.	Mileage
Erie R. R. (and Chicago & Erie). Continued.		
F. A. Knapp, Jersey City, N. J.		
W. H. Matthews, Hornell, N. Y.		
Neil McLean, Huntington, Ind.		
A. Swartz, Huntington, Ind.		
W. H. Wilkinson, Elmira, N. Y.		
Florida East Coast Ry.	1	708
E. K. Barrett, St. Augustine, Fla.		
Fort Smith & Western R. R.	1	217
B. F. Beckman, Ft. Smith, Ark.		
Fort Worth & Denver City Ry.	1	454
J. M. Mann, Ft. Worth, Tex.		
Georgia & Florida Ry.	1	325
W. A. Swallow, Augusta, Ga.		
Grand Rapids & Indiana Ry.	2	592
W. S. McKeel, Grand Rapids, Mich.		
H. M. Large, Ft. Wayne, Ind.		
Grand Trunk Ry. System	4	4,756
A. Findley, Montreal, Que.		
George A. Mitchell, Toronto, Ont.		
H. C. Swartz, St. Thomas, Ont.		
C. F. Warcup, St. Thomas, Ont.		
Grand Trunk Pacific Ry.	2	2,440
L. H. Wheaton, Moncton, N. B.		
K. J. C. Zinck, Winnipeg, Man.		
Gulf, Colorado and Santa Fé Ry.	5	1,518
E. C. George, Beaumont, Tex.		
K. S. Hull, Temple, Tex.		
R. A. Luker, Silsbee, Tex.		
W. G. Massenburg, Beaumont, Tex.		
W. W. Wilson, Galveston, Tex.		
Hampshire Southern R. R.	1	38
W. Trapnell, Romney, W. Va.		
Illinois Central R. R.	10	4,750
P. Aagaard, Chicago, Ill.		
F. O. Draper, Chicago, Ill.		
C. Ettinger, Chicago.		
T. J. Fullem, Chicago, Ill.		
R. J. McKee, Freeport, Ill.		
Samuel P. Munson, Mattoon, Ill.		
William Reed, Grenada, Miss.		
C. E. Thomas, Chicago, Ill.		
F. L. Thompson, Chicago, Ill.		
E. F. Wise (retired), Waterloo, Ia.		
Illinois Traction System	1	420
G. A. Wright, Decatur, Ill.		
Indianapolis, Columbus & Southern Traction Co.	1	62
A. Shane, Columbus, Ind.		
Intercolonial Ry.	8	1,468
T. C. Burpee, Moncton, N. B.		
John Forbes, Halifax, N. S.		
Hugh Jardine, Moncton, N. B.		

Name of Road and Membership.	Members.	Mileage
Intercolonial Ry. Continued.		
A. E. Killam, Moncton, N. B.		
H. J. McGrath, Moncton, N. B.		
W. B. McKenzie, Moncton, N. B.		
Thomas Sefton, Moncton, N. B.		
A. C. Selig, Moncton, N. B.		
International & Great Northern Ry.	1	1,106
H. M. Jack, Palestine, Tex.		
Kansas City, Clinton & Springfield Ry.	1	155
J. B. Browne, Clinton, Mo.		
Kansas City Southern Ry.	2	762
C. E. Johnston, Kansas City, Mo.		
J. J. Taylor, Texarkana, Tex.		
Lake Erie & Western Ry.	2	882
P. P. Lawrence, Tipton, Ind.		
J. N. Penwell, Tipton, Ind.		
Lake Shore & Michigan Southern Ry.	4	1,663
Willard Beahan, Cleveland, O.		
Philip O'Neill, Adrian, Mich.		
R. H. Reid, Cleveland, O.		
J. L. Soisson, Norwalk, O.		
Lake Superior & Ishpeming Ry., Munising Ry., and Marquette & S. E. Ry.	2	160
August Anderson, Marquette, Mich		
Roscoe C. Young, Marquette, Mich.		
Lehigh & Hudson River Railway	2	96
J. E. Barrett, Warwick, N. Y.		
Lewis A. Riley, Warwick, N. Y.		
Lehigh & New England R. R.	1	170
W. E. Harwig, Bethlehem, Pa.		
Lehigh Valley R. R.	8	1,446
E. B. Ashby, New York City.		
Peter Hofecker, Auburn, N. Y.		
J. W. Holcomb, Buffalo, N. Y.		
Judson Joslin, Auburn, N. Y.		
David A. Keefe, Athens, Pa.		
A. E. Kemp, Hazleton, Pa.		
F. E. Schall, South Bethlehem, Pa.		
E. R. Wenner, Ashley, Pa.		
Long Island R. R.	3	392
Chas. Wehlen, Jamaica, N. Y.		
W. Wicks, Amityville, N. Y.		
C. W. Wright, Jamaica, N. Y.		
Louisiana & Arkansas Ry.	1	255
W. H. Vance, Stamps, Ark.		
Louisville & Nashville R. R.	8	4,609
J. M. Bibb, Birmingham, Ala.		
A. J. Catchot, Ocean Springs, Miss.		
R. O. Elliott, Columbia, Tenn.		
H. R. Hill, Birmingham, Ala.		
Floyd Ingram, Erin, Tenn.		
A. B. McVay, Evansville, Ind.		
Wm. Sheley, Evansville, Ind.		
H. Stamler, Paris, Ky.		

Name of Road and Membership.	Members.	Mileage
Maine Central R. R.	1	1,180
P. N. Watson, Brunswick, Me.		
Michigan Central R. R.	5	1,803
S. D. Bailey, Detroit, Mich.		
Thomas Hall, St. Thomas, Ont.		
Henry A. Horning, Jackson, Mich.		
P. E. Schneider, Jackson, Mich.		
J. T. Webster, St. Thomas, Ont.		
Minneapolis & St. Louis R. R.	1	1,626
Ed. Gagnon, Minneapolis, Minn.		
Minneapolis, St. Paul & Sault Ste. Marie Ry.	3	3,770
A. Amos, Minneapolis, Minn.		
P. Swenson, Minneapolis, Minn.		
G. A. Manthey, Minneapolis, Minn.		
Miss. River & Bonne Terre Ry.	1	46
C. H. Fake, Bonne Terre, Mo.		
Missouri, Kansas & Texas Ry.	1	3,073
A. S. Clopton, Parsons, Kans.		
Missouri Pacific Ry. System (including St. Louis, Iron Mountain & Southern Ry.)	19	7,231
E. E. Allard, St. Louis, Mo.		
Robert J. Bruce, St. Louis, Mo.		
J. A. Costolo, St. Louis, Mo.		
E. M. Dolan, St. Louis, Mo.		
A. H. Ferdina, St. Louis, Mo.		
C. Gnadt, Poplar Bluff, Mo.		
Lon Graves, Monroe, La.		
W. Hausgen, Sedalia, Mo.		
E. P. Hawkins, Bastrop, La.		
W. J. Lacy, Poplar Bluff, Mo.		
G. W. Land, Eudora, Ark.		
C. E. Redmond, Van Buren, Ark.		
C. E. Smith, St. Louis, Mo.		
E. A. Stanley, St. Louis, Mo.		
Wm. Sullivan, Kansas City, Mo.		
F. W. Tanner, St. Louis, Mo.		
L. J. Wackerle, Kansas City, Mo.		
A. L. Waits, Argenta, Ark.		
C. H. Walther, Poplar Bluff, Mo.		
Mobile & Ohio R. R.	2	1,114
W. B. Harris, Murphysboro, Ill.		
B. F. Whiting, Murphysboro, Ill.		
Nashville, Chattanooga & St. Louis Ry.	1	1,230
I. O. Walker, Paducah, Ky.		
National Rys. of Mexico	1	6,177
Hans Bentele, Mexico City, Mex.		
New South Wales Government Rys.	1	3,472
James Fraser, Sydney, N. S. W.		
New York Central & Hudson River R. R.	8	2,829
G. J. Klumpp, Rochester, N. Y.		
R. P. Mills, New York City.		
Kemper Peabody, N. Y. City.		
W. A. Pettis, Rochester, N. Y.		

Name of Road and Membership.	Members.	Mileage
New York Central & Hudson River R. R. Continued.		
John Schaffer, Rochester, N. Y.		
H. C. Thompson, Weehawken, N. J.		
C. C. Warne, New York City.		
E. E. Wilson, New York City.		
New York, New Haven & Hartford R. R.	13	2,091
Grosvenor Aldrich, Readville, Mass.		
J. S. Browne, Providence, R. I.		
Wm. Graham, New Haven, Conn.		
H. H. Kinzie, Taunton, Mass.		
Wm. H. Moore, New Haven, Conn.		
B. P. Phillips, Willimantic, Conn.		
H. W. Phillips (retired), South Braintree, Mass.		
L. H. Porter (retired), Andover, Conn.		
George A. Rodman, New Haven, Conn.		
George T. Sampson, Boston, Mass.		
W. B. Schuessler, New Haven, Conn.		
D. W. Sharpe, New Haven, Conn.		
J. B. Sheldon, Providence, R. I.		
New York, Ontario & Western R. R.	1	494
J. H. Nuelle, Middletown, N. Y.		
New Zealand Government Rys.	2	2,717
C. H. Biss, Christchurch, N. Z.		
George A. Troup, Wellington, New Zealand.		
Northern Pacific Ry.	6	6,029
F. R. Bartles, Pasco, Wash.		
James Hartley, Staples, Minn.		
F. Ingalls, Jamestown, N. D.		
C. S. McCully, Jamestown, N. D.		
R. E. McFarlane, Duluth, Minn.		
J. C. Taylor, Glendive, Mont.		
North Western Govt. Rys. (India)	1	4,431
D. M. Cookson, Kalaw, Burma, India.		
Northwestern Pacific R. R.	1	372
A. A. Robertson, San Rafael, Cal.		
Oregon Short Line R. R.	8	1,646
J. F. Cullen, Pocatello, Idaho.		
W. C. Dale, Salt Lake City.		
O. Forsgren, Brigham, Utah.		
A. H. King, Salt Lake City, Utah.		
C. T. Musgrave, Idaho Falls, Idaho.		
P. E. Parsons, Salt Lake City.		
S. J. Powell, Ogden, Utah.		
R. B. Robinson, Rupert, Idaho.		
Pennsylvania Lines West of Pittsburg	8	2,763
Samuel C. Bowers, Steubenville, O.		
Stanton Bowers, Bradford, O.		
B. F. Gehr, Richmond, Ind.		
A. F. Miller, Chicago, Ill.		
D. G. Musser, Wellsville, O.		
H. H. Pollock, Carnegie, Pa.		
J. Wallenfelsz, Cambridge, O.		
D. C. Zook, Fort Wayne, Ind.		
Pennsylvania R. R.	5	5,304
M. M. Barton, West Philadelphia, Pa.		
Richard G. Develin, Philadelphia, Pa.		

Name of Road and Membership.	Members.	Mileage
Pennsylvania R. R. Continued.		
H. R. Leonard, Philadelphia, Pa.		
Robert McKibbon, Altoona, Pa.		
C. W. Richey, Pittsburg, Pa.		
Pere Marquette R. R.	7	2,336
J. D. Black, Saginaw, Mich.		
Edw. Guild, Edmore, Mich.		
G. E. Hanks, East Saginaw, Mich.		
A. McNab, Holland, Mich.		
John Robinson, Grand Rapids, Mich.		
J. E. Toohey, Grand Rapids, Mich.		
J. P. Wood, Edmore, Mich.		
Philadelphia & Reading Ry.	5	1,490
Amos H. Beard, Reading, Pa.		
John Foreman (retired), Pottstown, Pa.		
W. W. Perry, Williamsport, Pa.		
E. G. Storck, Philadelphia, Pa.		
E. E. Templin, Pottsville, Pa.		
Pittsburg & Lake Erie R. R.	2	215
D. L. McKee, McKee's Rocks, Pa.		
G. H. Soles, Pittsburg, Pa.		
Queen & Crescent Route	1	509
E. L. Loftin, Vicksburg, Miss.		
Quincy, Omaha & Kansas City R. R.	1	261
T. F. DeCapito, Milan, Mo.		
San Antonio & Aransas Pass Ry.	1	724
G. J. Bishop, Yoakum, Tex.		
San Pedro Los Angeles & Salt Lake R. R.	3	1,075
F. M. Bigelow, Salt Lake City, Utah.		
W. C. Frazier, Los Angeles, Cal.		
D. W. Scannell, Salt Lake City.		
Seaboard Air Line Ry.	10	3,046
W. M. Barker, Scotia, S. C.		
P. W. Cahill, Tallahassee, Fla.		
B. B. Christy, Tallahassee, Fla.		
W. J. Gooding, Jr., Savannah, Ga.		
B. Land, Jr., Jacksonville, Fla.		
W. A. McDearmid, Tallahassee, Fla.		
J. C. Nelson, Portsmouth, Va.		
G. B. Smith, Jacksonville, Fla.		
J. A. Wilson, Woodbine, Fla.		
J. L. Winter, Waldo, Fla.		
St. Joseph & Grand Island Ry.	2	319
O. H. Andrews, St. Joseph, Mo.		
Wm. Carmichael, St. Joseph, Mo.		
St. Louis & San Francisco R. R.	1	4,740
F. G. Jonah, St. Louis.		
St. Louis, Rocky Mt. & Pac. R. R.	1	106
Alf Brown, Raton, N. M.		
St. Louis Southwestern Ry.	2	1,451
J. S. Berry, St. Louis, Mo.		
Wm. Quinn, Tyler, Tex.		

Name of Road and Membership.	Members.	Mileage
Southern Ry.	14	7,089

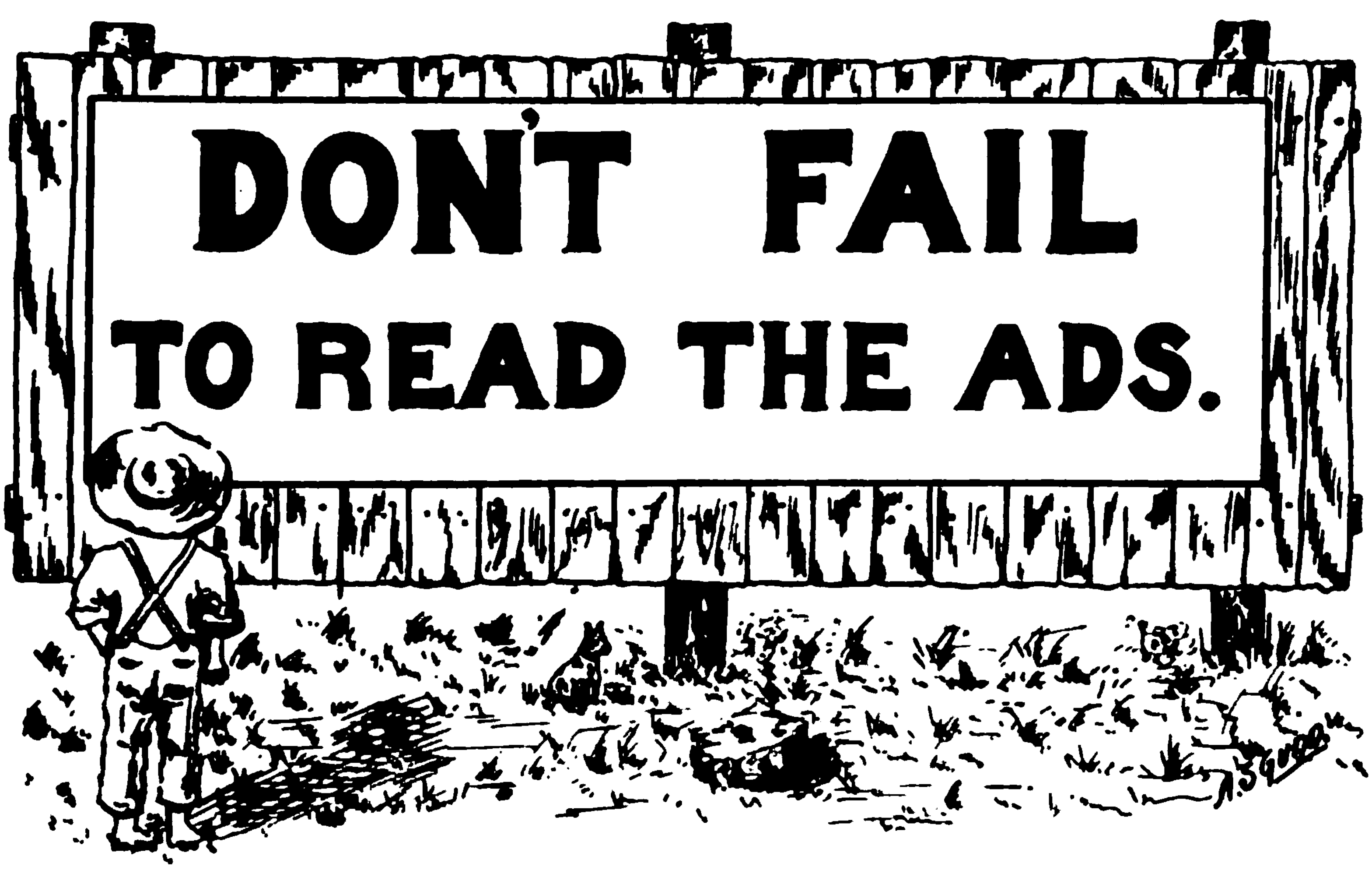
D. A. Ballenger, Greenville, S. C.
J. H. Blackwell, Charleston, S. C.
James T. Carpenter, Princeton, Ind.
H. S. Douglass, Charleston, S. C.
W. F. Fraylick, Charleston, S. C.
J. R. Fowlkes, Columbia, S. C.
N. L. Hall, Greensboro, N. C.
Joseph A. Killian, Jr., Charlotte, N. C.
J. S. Lemond, Charlotte, N. C.
D. W. Lum, Washington, D. C.
J. W. Morgan, Columbia, S. C.
T. E. Sharpe, Greenville, S. C.
J. B. Teaford, Princeton, Ind.
G. W. Welker, Alexandria, Va.

Southern Pacific Company	44	6,663

C. J. Astrue, Oakland Pier, Cal.
T. W. Bratten, West Oakland, Cal.
H. Bulger, Oakland Pier, Cal.
W. H. Burgess, Stockton, Cal.
D. Burke, Tucson, Ariz.
J. T. Caldwell, Bakersfield, Cal.
W. S. Corbin, Los Angeles, Cal.
Geo. Dickson, Oakland, Cal.
F. M. Drake, San Francisco.
B. F. Ferris, Los Angeles, Cal.
J. F. Fisher, Sacramento, Cal.
M. Fisher, Ogden, Utah.
A. Fraser, Bakersfield, Cal.
Neil Fraser, Sacramento, Cal.
P. Fritz, Los Angeles.
J. A. Givens, Sacramento, Cal.
Jas. Gratto, Los Angeles, Cal.
C. F. Green, Sacramento, Cal.
P. Guisto, San Francisco.
W. C. Harmon, Bakersfield, Cal.
J. Hubley, Colfax, Cal.
C. A. Jensen, Los Angeles.
A. W. Lasher, Suisun, Cal.
T. J. Linehan, Ventura, Cal.
H. Lodge, San Francisco.
J. B. Malloy, San Francisco.
J. D. Mathews, Tucson, Ariz.
F. D. Mattos, W. Oakland, Cal.
C. W. McCandless, Ventura, Cal.
D. McGee, Sacramento, Cal.
A. M. McLeod, Oakland, Cal.
E. C. Morrison, San Francisco.
P. N. Nelson, San Francisco. Cal.
H. Pollard, San Francisco, Cal.
Geo. W. Rear, San Francisco, Cal.
J. S. Replogle, Oakland, Cal.
D. T. Rintoul, Bakersfield, Cal.
A. L. Robinson, Stockton, Cal.
W. W. Sheldon, Oakland, Cal.
F. M. Siefer, Oakland Pier, Cal.
E. J. Vincent, Los Angeles.
A. Weldon, Bakersfield, Cal.
J. G. Wiley, Dunsmuir, Cal.
M. M. Wilson, Los Angeles, Cal.

Name of Road and Membership.	Members.	Mileage
Tennessee, Alabama & Georgia R. R.	1	98
C. H. Fisk, Chattanooga, Tenn.		
Tennessee Central R. R.	2	326
E. M. Carter, Nashville, Tenn.		
J. M. Hurt, Nashville, Tenn.		
Texas & Pacific Ry.	1	1,885
E. Loughery, Marshall, Tex.		
Texas Midland R. R.	1	125
E. H. R. Green, Terrell, Tex.		
Toledo, Peoria & Western Ry.	1	248
J. H. Markley, Peoria, Ill.		
Union Pacific R. R.	2	3,498
Wm. A. Conkling, Omaha, Neb.		
J. Parks, Denver, Colo.		
Vandalia R. R.	1	829
J. L. McKee, Spencer, Ind.		
Wabash R. R.	2	2,514
A. O. Cunningham, St. Louis, Mo.		
William S. Danes, Peru, Ind.		
Washington Terminal Co.	2	53
W. M. Cardwell, Washington, D. C.		
C. H. Spencer, Washington, D. C.		
Wellington & Manawata Ry. (New Zealand)	1	84
Arthur Williams, Wellington, New Zealand.		
Western Australia Government Rys.	2	1,943
W. J. George, Perth, Western Australia.		
E. S. Hume, Midland Jct., Western Australia.		
Western Pacific Ry.	3	934
T. J. Stuart, Elko, Nev.		
M. R. Krutsinger, Sacramento, Cal.		
Norton Ware, San Francisco.		
Wheeling & Lake Erie R. R.	3	496
Wm. Mahan, Canton, O.		
W. L. Rohbock, Cleveland, O.		
C. A. Stelle, Canton, O.		
Yazoo & Miss. Valley R. R.	2	1,370
D. H. Holdridge, Vicksburg, Miss.		
No. of members with roads	437	
Total mileage represented		230,529
Other members not connected with roads	62	
Total number of members	499	

INDEX TO ADVERTISEMENTS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Eastern Sales Agents
QUINCY & GILMAN
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Steel gravity feeder accurately measures the coal and insures a full load for each trip of the bucket, without the coal being spilled.

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4

PROCEEDINGS OF THE

Twenty-Second Annual Convention

OF THE

American Railway Bridge and Building Association

HELD AT

BALTIMORE, MARYLAND

October 15-17, 1912

REPORTS IN THIS ISSUE

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PUBLISHED BY THE ASSOCIATION
C. A. Lichty, Secretary
226 W. JACKSON BOULEVARD
CHICAGO, ILL.

The **Twenty-third Annual Convention will be held at Montreal, October 21-23**

1913

PROCEEDINGS OF THE

Twenty-Second Annual Convention

OF THE

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION

Successor to the

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS

HELD AT

BALTIMORE, MD.

OCTOBER 15-17, 1912

Official Badge

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BRETHREN PUBLISHING HOUSE
ELGIN, ILLINOIS
1913

A. E. KILLAM

INTERCOLONIAL RAILWAY OF CANADA

President, 1912-13

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OFFICERS FOR 1912-13

A. E. KILLAM, ... PRESIDENT
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J. N. PENWELL, ... FIRST VICE-PRESIDENT
Lake Erie & Western R. R., Tipton, Ind.

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Chicago, Milwaukee & St. Paul Ry., Chicago, Ill.

T. J. FULLEM, ... THIRD VICE-PRESIDENT
Illinois Central R. R., Chicago, Ill.

G. ALDRICH, ... FOURTH VICE-PRESIDENT
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Chicago & Northwestern Ry., Chicago, Ill.

J. P. CANTY, ... TREASURER
Boston & Maine R. R., Boston, Mass.

S. F. PATTERSON, Secretary Emeritus, ... Concord, N. H.

THE EXECUTIVE COMMITTEE

Consists of the Officers and the following Members:

G. W. REAR, Southern Pacific Co., ... San Francisco, Cal.

W. F. STEFFENS, Boston & Albany R. R., ... Boston, Mass.

E. B. ASHBY, Lehigh Valley R. R., ... New York City

C. E. SMITH, Missouri Pacific Ry., ... St. Louis, Mo.

S. C. TANNER, Baltimore & Ohio R. R., ... Baltimore, Md.

LEE JUTTON, Chicago & Northwestern Ry., ... Chicago, Ill.

PAST PRESIDENTS

1891-92	O. J. Travis,	Pinehurst, Wash.
1892-93	*H. M. Hall,	Ohio & Mississippi Ry., Olney, Ill.
1893-94	*J. E. Wallace,	Wabash R. R., Springfield, Ill.
1894-95	G. W. Andrews,	Baltimore, Md.
1895-96	W. A. McGonagle,	D: M. & N. Ry., Duluth, Minn.
1896-97	James Stannard,	Kansas City, Mo.
1897-98	*Walter G. Berg,	Lehigh Valley R. R., New York City
1898-99	J. H. Cummin,	Bay Shore, N. Y.
1899-00	A. S. Markley,	Chicago & Eastern Illinois R. R., Danville, Ill.
1900-01	W. A. Rogers,	37 W. Van Buren St., Chicago, Ill.
1901-02	W. S. Danes,	Wabash R. R., Peru, Ind.
1902-03	B. F. Pickering,	Boston & Maine R. R., Salem, Mass.
1903-04	A. Montzheimer,	Elgin, Joliet & Eastern Ry., Joliet, Ill.
1904-05	C. A. Lichty,	Chicago & Northwestern Ry., Chicago, Ill.
1905-06	J. B. Sheldon,	N. Y. N. H. & H. R. R., Providence, R. I.
1906-07	J. H. Markley,	Toledo, Peoria & Western Ry., Peoria, Ill.
1907-08	R. H. Reid,	L. S. & M. S. Ry., Cleveland, O.
1908-09	J. P. Canty,	Boston & Maine R. R., Boston, Mass.
1909-10	J. S. Lemond,	Southern Ry., Charlotte, N. C.
1910-11	H. Rettinghouse,	C. & N. W. Ry., Mason City, Ia.
1911-12	F. E. Schall,	Lehigh Valley R. R., So. Bethlehem, Pa.

*Deceased.

SUBJECTS AND COMMITTEE APPOINTMENTS FOR 1913

1. Water Supply.

C. R. Knowles, Chairman, I. C. R. R., Chicago.
J. Dupree, 5608 So. Aberdeen St., Chicago.
John Ewart, B. & M. R. R., Boston, Mass.
J. B. White, C. & N. W. Ry., Boone, Ia.
Guy Gordon, C. R. I. & P. Ry., Little Rock, Ark.
C. F. Warcup, G. T. Ry., St. Thomas, Ontario.

2. Track Scales.

A. M. Van Auken, Chairman, F. E. C. Ry., St. Augustine, Fla.
C. E. Smith, Mo. Pac. Ry., St. Louis, Mo.
R. C. Sattley, C. R. I. & P. Ry., Chicago, Ill.
H. M. Jack, I. & G. N. R. R., Palestine, Tex.
G. H. Soles, P. & L. E. R. R., Pittsburgh, Pa.

3. Equipment and Tools for Bridge Gangs.

A. Yappen, Chairman, C. M. & St. P. Ry., Chicago.
R. H. Reid, L. S. & M. S. Ry., Cleveland, O.
F. O. Draper, I. C. R. R., Chicago.
J. A. Killian, Sou. Ry., Charlotte, N. C.

4. Concrete Culverts and Various Kinds of Pipe for Culverts.

L. D. Hadwen, Chairman, C. M. & St. P. Ry., Chicago.
O. F. Dalstrom, C. & N. W. Ry., Chicago, Ill.
C. J. Scribner, C. B. & Q. Ry., Chicago.
W. L. Rohbock, W. & L. E. R. R., Cleveland, O.

5. Heating, Lighting and Ventilating of Roundhouses and Shops.

G. W. Hand, Chairman, C. & N. W. Ry., Chicago, Ill.
M. A. Long, B. & O. R. R., Baltimore, Md.
G. H. Jennings, E. J. & E. R., Perry, Iowa.
E. E. Clothier, C. M. & St. P. Ry., Perry, Iowa.

6. Sewers and Drains.

R. O. Elliott, Chairman, L. & N. R. R., Nashville, Tenn.
A. F. Miller, P. R. R., Chicago, Ill.
E. C. Morrison, Sou. Pac. Co., San Francisco, Cal.
K. Peabody, N. Y. C. & H. R. R. R., New York City.

7. Motor Cars for Bridge Gangs.

R. C. Young, Chairman, L. S. & I. Ry., Marquette, Mich.
A. Montzheimer, E. J. & E. Ry., Joliet, Ill.
C. H. Fake, M. R. & B. T. R. R., Bonne Terre, Mo.
P. Swenson, Soo Line, Minneapolis, Minn.

8. Temporary Structures for Supporting Tracks During Construction of Permanent Work, Sewers, etc.

W. C. Whitney, Chairman, B. & A. R. R., Boston, Mass.
J. P. Canty, B. & M. R. R., Boston, Mass.
G. Aldrich, N. Y. N. H. & H. R. R., Boston, Mass.
J. B. Sheldon, N. Y. N. H. & H. R. R., Providence, R. I.

9. Concrete Posts, Poles and Signs.

G. E. Boyd, Chairman, D. L. & W. R. R., Scranton, Pa.
F. L. Thompson, I. C. R. R., Chicago, Ill.
A. S. Markley, C. & E. I. R. R., Danville, Ill.

10. Snow Fences.

A. H. King, Chairman, O. S. L. R. R., Salt Lake City, Utah
C. E. King, C. & N. W. Ry., Omaha, Neb.
F. E. King, C. M. & St. P. Ry., Minneapolis, Minn.
Frank Lee, C. P. R., Winnipeg, Manitoba.
C. S. McCully, N. P. Ry., Jamestown, No. Dak.

11. Preservation of Timber.

G. W. Rear, Chairman, Sou. Pac. Co., San Francisco, Cal.
F. D. Beal, 912 Yeon Bldg., Portland, Ore.
F. D. Mattos, Sou. Pac. Co., West Oakland, Cal.
A. J. Catchot, L. & N. R. R., Ocean Springs, Miss.

12. Cattle Guards.

Arthur Ridgway, Chairman, D. & R. G. R. R., Denver, Colo.
Daniel Burke, Sou. Pac. Co., Tucson, Ariz.
D. A. Ballenger, Southern Ry., Greenville, N. C.
J. W. Fletcher, Car. & N. W. Ry., Chester, S. C.
W. V. Parker, C. R. I. & P. Ry., Amarillo, Tex.
H. J. McGrath, I. C. R. of Can., Moncton, N. B.

13. Fire-Resisting Coatings for Timber.

Lee Jutton, Chairman, C. & N. W. Ry., Chicago.
W. H. Moore, N. Y. N. H. & H. R. R., New Haven, Conn.
W. H. Finley, C. & N. W. Ry., Chicago.
C. T. Musgrave, O. S. L. R. R., Idaho Falls, Idaho.
J. S. Robinson, C. & N. W. Ry., Chicago.
E. S. Meloy, C. M. & St. P. Ry., Chicago.

NOMINATIONS.

R. H. Reid, L. S. & M. S. Ry., Cleveland, O.
S. F. Patterson, B. & M. R. R., Concord, N. H.
J. B. Sheldon, N. Y. N. H. & H. R. R., Providence, R. I.
G. W. Andrews, B. & O. R. R., Baltimore, Md.

SUBJECTS.

F. E. Weise, C. M. & P. Ry., Chicago.
C. E. Smith, Mo. Pac. Ry., St. Louis, Mo.
W. F. Strouse, B. & O. R. R.
B. F. Pickering, B. & M. R. R., Salem, Mass.

RELIEF.

A. Montzheimer, E. J. & E. Ry., Joliet, Ill.

MEMBERSHIP.

J. B. Gaut, G. T. Ry., Montreal, Que.
J. E. Travis, G. T. Ry., Toronto, Ont.
Frank Lee, C. P. R., Winnipeg, Manitoba.
G. S. Kibbey, M. & St. L. R. R., Minneapolis, Minn.

PUBLICATIONS.

R. C. Sattley, C. R. I. & P. Ry., Chicago, Ill.
L. D. Hadwen, C. M. & St. P. Ry., Chicago, Ill.
Lee Jutton, C. & N. W. Ry., Chicago, Ill.

ARRANGEMENTS.

Phelps Johnson, Dom. Bridge Co., Montreal, Que.
J. B. Gaut, G. T. Ry., Montreal, Que.

OBITUARY.

J. N. Penwell, L. E. & W. R. R., Tipton, Ind.

Proceedings of the Twenty-second Annual Convention

OF THE

American Railway Bridge and Building Association

HELD IN THE EMERSON HOTEL

Baltimore, Md., October 15, 16 and 17, 1912

MORNING SESSION.

Tuesday, Oct. 15, 1912.

The twenty-second annual convention was called to order at 10 A. M., by President F. E. Schall.

Prayer was offered by Mr. J. N. Penwell.

The President:—Ladies and Gentlemen, Members of the American Railway Bridge and Building Association: As far as I know, this is the first meeting held by this association in Baltimore, and I dare say that many of us know little concerning the city. The gentleman who is to address us now will no doubt enlighten us in regard to the special characteristics of this beautiful city. I now have the pleasure of introducing to you Mr. Robert E. Lee, secretary to the Honorable Mayor of the City of Baltimore.

Mr. Lee:—Mr. Chairman, Ladies and Gentlemen: I am indeed sorry that business of great importance affecting the municipality, made it impossible for the mayor to be personally present with you this morning, as he would have liked to be, but, as you are all practical men doing the world's work each day, you know what it means to be the chief executive of a great city such as this is, and are well aware of the many demands upon his time making it absolutely impossible for him to attend all the functions that he would like to be able to attend. Therefore the duty devolved upon me on this occasion, to welcome to our beautiful city this splendid gathering of my fellow citizens. I see by the back of your program that someone has very prop-

erly and appropriately given you some idea regarding the extent to which our community has blazed the way in many of the important things that affect the progress of our country. I will be relieved, therefore, from going into those details, because, if you look on the back of this little folder, you will find that Baltimore and Maryland have been the pioneers in many historic events and in many of the great events that have so blessed our people and made our country great and prosperous. We have today in this city many things that I think probably would be especially interesting to a gathering of gentlemen whose lifework is that of doing things that the people must have done and cannot do without. There are two sides to nearly all things that one might undertake to argue about. One might doubt whether we should have protection or free trade; or whether our tariff should be revised up or down, but one cannot deny that we must have railroads and bridges and men to build them, in order that this country may grow and prosper.

We are today carrying on as great public improvements as you will find at one time in any city of similar size in the United States. Since the great fire that devastated the entire business district and wiped out the place where we now sit, we have appropriated nearly sixty million dollars in order to beautify our city and make it more healthful and more comfortable for our people to live in. We are building a great sewer system that we claim is the greatest sewer system in any American city. We are laying out a great mileage of streets, some ten million dollars' worth of paving being undertaken at one time, due, in a large measure to the fact that we had the old cobble stone pavement, which has been laid on the streets of our city since its early foundation. We expect to remove all of this within the period of four or five years. Then we have what we call the Falls Way, where we are converting a stream that flows through the city and that has been an eyesore to our people, into one of the great assets of our city, a splendid driveway and a great artery that will help to solve our sewerage problem. And all over the city, if you care to wander, you will find great improvements that will interest practical men who do things. We have other things that will interest you and the ladies. We have a beautiful park system. I think I may say, without successful contradiction, that we have here one of the most beautiful public parks that can be seen anywhere in the United States. It is not as large as some other

parks, but it is larger than many, and it is a natural beauty spot that cannot be surpassed anywhere. In our park system, we have a combined acreage of 2,650 acres, connected by a boulevard that takes you from the southeastern section through all the parks of the city and lands you in the southwestern section. Then we have a great many places of historic interest; the Peabody Institute, the Johns Hopkins University, the Walters Art Gallery and many places that you will find printed on the back of your folder and to which it will not be necessary for me to call your attention. I am glad, to see in this convention, a greater number of the ladies than we ordinarily find in conventions of this kind, and I have thought that probably this is due to the fact that practical men who create wealth always see that they get a little bit for themselves and probably they are able to bring their wives with them.

We are proud of our history. You are standing on a spot almost as historic as any in the Union. Maryland has always given liberally of her brains, her talents and her sons to make the country's history great and grand. You stand within the shadow of the first monument erected to the memory of George Washington. You stand within easy distance of the place where Washington laid down the command of the army and navy of the United States. You stand within sight and easy distance of the place where Francis Scott Key penned his immortal anthem. and you are within a few hours' ride of the western section of our State, where sleeps one of the noblest characters and bravest admirals who ever directed the course of a ship, Winfield Scott Schley. And, my good people, I might go on and detail to you the great historic events that have taken place in our state and the men who have participated in them, but I know you are busy people and will not detain you much longer. We hang out to you the latch key, extending a genuine and cordial welcome and bid you Godspeed in the work you are to perform.

The President:—I am sure we all appreciate the hearty welcome extended by Mr. Lee, and I ask Mr. J. H. Cummin to respond.

Mr. Cummin:—Mr. Lee, in behalf of the members of our association, the ladies, and friends: I want to thank you not only in their behalf, but in my own, for the warm, cordial welcome that you have given us to your city. These men who are members of this association, I can assure you, Mr. Lee, are the most

optimistic group of men you ever had the pleasure of meeting. I don't believe there is one of them but that is even more optimistic than the Irishman who was working on a sky scraper in New York a short time ago. He had been working on the seventeenth floor and accidentally slipped and went down a hatchway. As he was going by the third floor, one of his mates heard him say, "Begorra, I'm all right yet." (Laughter.)

I can assure you, Mr. Lee, that we are glad to meet in Baltimore. This is an association composed of men who have very little spare time. The majority of the members attending these meetings take this as their only vacation during the year. They come here to listen to the reports of the different committees and to discuss those subjects, earnestly striving in every way to better fit themselves for the duties they are called upon to perform, and going home with the feeling that they have added to their knowledge and ability, and are in every way better prepared to work for the company by whom they are employed. They are a body of true, earnest, hardworking men. As I walked through your streets yesterday afternoon, it brought to my mind the first time that I ever saw your city. It was in the dark days of 1861. When we reached Philadelphia twenty rounds of cartridges were issued to each man. At that time, the railroads did not go through your city and we had to disembark at one side of the city, march through and embark on the other side for Washington. Those were indeed dark days, but, as General Fitzhugh Lee said to us at a meeting in Washington just at the close of the Spanish-American war, that year there had been erected a grand, long, broad and noble bridge over the chasm that had existed between the different parts of the country for so many years, and today, in 1912, we can meet in Baltimore or in any section of this country, all living, working and having our being under one flag and that flag the grandest banner that has even been thrown to the breeze by any nation on the face of this earth. (Applause.) Mr. Lee, again I thank you for your kind words and I can assure you that we appreciate your coming here —leaving the many arduous duties that come before you and spending so much of your time with us. (Applause.)

The Secretary:—Before the ladies retire I wish to read a letter from Mrs. Noon. (A letter was then read from Mrs. W. M. Noon, Palatka, Florida, in which she gave the reasons for Mr.

Noon and herself not being able to attend the convention, as they had planned.)

The President:—We will now have a short recess to permit the ladies to retire from the room, after which we will resume our regular order of business.

(Short recess.)

The President:—The first order of business is the roll call, but as we use the card registration system we will not have to go through the formality of calling the roll. The registration showed the following members present:

MEMBERS PRESENT AT THE 1912 CONVENTION.

AAGAARD, P., Supvr. B. & B., I. C. R. R., Chicago.
ALDRICH, G., Supvr. B. & B., N. Y. N. H. R. R., Boston.
ALEXANDER, W. E., Supt., B. & B., B. & A. R. R., Houlton, Me.
ANDREWS, G. W., Inspr. Maintenance, B. & O. R. R., Baltimore.
ARNOLD, F. J., Gen. For. B. & B., D. L. & W. R. R., Scranton, Pa.
BARTON, M. M., Mast. Carp., P. R. R., Philadelphia.
BEARD, A. H., For. Carp., P. & R. Ry., Reading, Pa.
BIBB, J. M., Supvr. B. & B., L. & N. R. R., Birmingham, Ala.
BOWERS, Stanton, Mast. Carp., P. C. C. & St. L. Ry., Bradford, O.
BOYD, Geo. E., Supt. B. & B., D. L. & W. R. R., Scranton, Pa.
BROWNE, J. B., Gen. For. B. & B., K. C. C. & S. Ry., Clinton, Mo.
BRUCE, R. J., Supt. of Buildings, Mo. Pac. Ry., St. Louis.
CANTY, J. P., Supt. B. & B., B. & M. R. R., Boston.
CARDWELL, W. M., Mast. Carp., Wash. Term. Co., Washington, D. C.
CASE, F. M., For. Water Service, C. & N. W. Ry., Belle Plaine, Ia.
CATCHOT, A. J., Supvr. B. & B., L. & N. R. R., Ocean Springs, Miss.
CLARK, W. M., Mast. Carp., B. & O. R. R., Pittsburgh.
CUMMIN, J. H., Bay Shore, N. Y.
DECKER, H. H., Eng. Maint., C. & N. W. Ry., Chicago.
DUPREE, Jas., For. Water Service, C. T. H. & S. E. Ry., Crete, Ill.
EGGERS, C. H., Mast. Carp., C. R. I. & P. Ry., Little Rock, Ark.
EGGLESTON, H. H., Asst. Mast. Carp., B. & O. C. T. R. R., Blue Island, Ill.
EGGLESTON, W. O., Br. Inspr., Erie R. R., Huntington, Ind.
ELLIOTT, R. C., Supvr. B. & B., L. & N. R. R., Nashville, Tenn.
ELWELL, H. A., Supvr. B. & B., C. G. W. R. R., Clarion, Iowa.
ETTINGER, Chas., For. Painter, I. C. R. R., Chicago.
EWART, John, Supt. Water Service, B. & M. R. R., Boston.
FLINT, C. F., For. B. & B., C. Vt. R. R., St. Albans, Vt.
GEHR, B. F., Mast. Carp., P. C. C. & St. L. Ry., Richmond, Ind.
GRIFFITH, F. M., Supvr. B. & B., C. & O. Ry., Covington, Ky.
HARWIG, W. E., Supvr. B. & B., L. & N. E. Ry., Bethlehem, Pa.
HOPKE, W. T., Mast. Carp., B. & O. R. R., Grafton, W. Va.
HUDSON, B. M., Gen. For. B. & B., T. & B. V. Ry., Teague, Tex.
HUNCIKER, John, For. Br. Erection, C. & N. W. Ry., Chicago.
JACK, H. M., Gen. For. B. & B., I. & G. N. R. R., Palestine, Tex.
JEWELL, J. O., Supt. B. & B., C. T. H. & S. E. Ry., Terre Haute, Ind.
JUTTON, Lee, Gen. Br. Inspr., C. & N. W. Ry., Chicago.
KEEFE, D. A., Cons. Engr., Athens, Pa.
KELLY, C. W., Fairbanks, Morse & Co., Chicago.
KILLAM, A. E., Inspr. B. & B., I. C. R. of Can., Moncton, N. B.
KING, A. H., Supvr. B. & B., O. S. L. R. R., Salt Lake City.
LARGE, H. M., Mast. Carp., G. R. & I. Ry., Ft. Wayne, Ind.

LICHTY, C. A., Genl. Inspr., C. & N. W. Ry., Chicago.
LOFTIN, E. L., Supvr. B. & B., Q. & C. Ry., Vicksburg, Miss.
MARKLEY, A. S., Mast. Carp., C. & E. I. R. R., Danville, Ill.
MARKLEY, J. H., Master B. & B., T. P. & W. Ry., Peoria, Ill.
McKEEL, W. S., Mast. Carp., G. R. & I. Ry., Grand Rapids, Mich.
McLEAN, Neil, Mast. Carp., Erie R. R., Huntington, Ind.
McNAB, A., Supvr. B. & B., P. M. R. R., Holland, Mich.
MILLS, R. P., Supvr. Bldgs., N. Y. C. & H. R. R. R., New York City.
MOORE, W. H., Engr. Bridges, N. Y. N. H. & H. R. R., New Haven, Conn.
MUSGRAVE, C. T., B. & B. For., O. S. L. R. R., Idaho Falls, Idaho.
MUSSER, D. G., Mast. Carp., Pa. Lines West, Wellsville, O.
NUELLE, J. H., Engr. M. of W., N. Y. O. & W. Ry., Middletown, N. Y.
PARKER, J. F., Gen. For. B. & B., A. T. & S. F. Ry., San Bernardino, Cal.
PATTERSON, S. F., B. & M. R. R., Concord, N. H.
PENWELL, J. N., Supvr. B. & B., L. E. & W. R. R., Tipton, Ind.
PICKERING, B. F., Supvr. B. & B., B. & M. R. R., Salem, Mass.
POTTS, J. O., M. of W. Inspr., B. & O. R. R., Baltimore.
REID, R. H., Supvr. Bridges, L. S. & M. S. Ry., Cleveland, O.
RINEY, M., For. B. & B., C. & N. W. Ry., Baraboo, Wis.
ROBINSON, J. S., Div. Engr., C. & N. W. Ry., Chicago.
SCHALL, F. E., Bridge Engr., L. V. R. R., So. Bethlehem, Pa.
SCHENCK, W. S., Mast. Carp., B. & O. R. R., Connellsville, Pa.
SHELDON, J. B., Supvr. B. & B., N. Y. N. H. & H. R. R., Providence, R. I.
SIBLEY, C. A., Const. Engr., New Haven, Conn.
SMITH, C. E., Bridge Engr., Mo. Pac. System, St. Louis, Mo.
SPENCER, C. H., Engr., Wash. Term. Co., Washington, D. C.
STATEN, J. M., Genl. Inspr. of Bridges, C. & O. Ry., Richmond, Va.
STORCK, E. G., Mast. Carp., P. & R. Ry., Philadelphia, Pa.
STROUSE, W. F., Asst. Engr., B. & O. R. R., Baltimore.
SWARTZ, H. C., Master B. & B., G. T. R., St. Thomas, Ont.
SWEENEY, W. M., For. B. & B., C. & N. W. Ry., Green Bay, Wis.
TANNER, S. C., Mast. Carp., B. & O. R. R., Baltimore.
TAYLOR, D. B., Mast. Carp., B. & O. R. R., Garrett, Ind.
TAYLOR, F. A., Mast. Carp., B. & O. R. R., Cumberland, Md.
TAYLOR, J. J., Supt. B. & B., K. C. S. Ry., Texarkana, Tex,
TEAFORD, J. B., Supvr. B. & B., Southern Ry., Lawrenceburg, Ky.
TEMPLIN, E. E., For. Carp., P. & R. Ry., Pottsville, Pa.
VANDEGRIFT, C. W., Supvr. B. & B., C. & O. Ry., Alderson, W. Va.
WALLENFELSZ, J., Mast. Carp., Pa. Lines West, Cambridge, O.
WARCUP, C. F., For. Water Service, G. T. R., St. Thomas, Ont.
WELKER, G. W., Supvr. B. & B., Southern Ry., Alexandria, Va.
WENNER, E. R., Supvr. B. & B., L. V. R. R., Ashley, Pa.
WOOD, J. P., For. B. & B., P. M. R. R., Edmore, Mich.
WRIGHT, C. W., Mast. Carp., L. I. R. R., Jamaica N. Y.
ZOOK, D. C., Mast. Carp., Pa. Lines West, Ft. Wayne, Ind.

The following applicants for membership subsequently elected were also present:

BLOWERS, S. H., For. Carp., B. & O. R. R., Columbus, O.
BOUTON, W. S., Engr. of Bridges, B. & O. R. R., Baltimore.
BRANTNER, Z. T., Gen. For. M. of W. Shops, B. &. O. R. R., Martinsburg, W. Va.
BRICKER, H. R., Inspr. M. of W., B. & O. R. R., Baltimore.
EDWARDS, W. R., Asst. Engr. Brdgs., B. & O. R. R., Baltimore.
ELDER, W. E., Mast. Carp., C. B. & Q. R. R., Burlington, Ia.
HENDERSON, J., B. & B. For., G. T. R., St. Thomas, Ont.
JAMES, A. J., Gen. For. B. & B., A. T. & S. F. Ry., Topeka, Kans.
KNOWLES, C. R., Gen. For. Waterworks, I. C. R. R., Chicago.
LANE, E. G., Asst. Engr., B. & O. R. R., Baltimore.

LONG, M. A., Architect, B. & O. R. R., Baltimore.
MACE, B. S., Supt. Insurance, B. & O. R. R., Baltimore.
MOORE, E. G., Carp. For., B. & O. R. R., Grafton, W. Va.
O'CONNOR, W. F., Supvr. Bridges, L. I. R. R., Flushing, N. Y.
THOMAS, T. E., Mast. Carp., B. & O. R. R., Wilmington, Del.
WHITNEY, W. C., Supr. B. & B., B. & A. R. R., Boston.

Total number of members registered, 103.

The President:—Next in order is the reading of the minutes of the last meeting, but as they have been published and every member has received a copy of the proceedings in which they are contained I do not deem it necessary to have them read at this time.

The next order of business is the admission of new members. We will now have the report of the membership committee.

REPORT OF COMMITTEE ON MEMBERSHIP.

Salt Lake City, Oct. 10, 1912.

This committee sent out its circulars and application blanks as in previous years where, in its judgment the best results could be obtained, with the object of soliciting only members who would prove creditable to this association, maintain its character for usefulness, and perpetuate its value as an aid to successful modern railway work. We believe that when our members realize that the purpose of this association is to perfect and simplify methods for the better execution of the branch of work assigned to our department the railway companies are being directly benefited, and the reason for our existence is apparent.

Our circulars show the purposes of our association, give the personnel of committees, subjects for discussion at this meeting, and a list of officers and executive members. The secretary of this association has materially assisted in the work of securing new members by sending out to each of the members a copy of the circular and causing to appear in the "Bulletin" an article bearing upon this subject. It will be noticed that the increase in membership is made up largely from the western half of the country although our members cannot be said to be confined to any one section. The increase numerically has been very gratifying as we now have more members than in any previous year of our history as an association.

The following list of applicants is submitted at this meeting for your consideration and their election to membership is recommended by the committee:—

NEW MEMBERS.

Ashton, D. H., Asst. Engr. Const., O. S. L. R. R., Salt Lake City.
Barr, Robt., Foreman B. and B., O. S. L. R. R., Pocatello, Idaho.
Bishop, R. R., For. B. and B., S. P. L. A. & S. L. R. R., Salt Lake City.
Blowers, S. H., For. Carp., B. & O. R. R., Columbus, O.
Bonner, J. K., Asst. Supvr. B. & B., N. Y. C. & H. R. R. R., Rochester, N. Y.

Bouton, W. S., Engr. of Bridges, B. & O. R. R., Baltimore, Md.
Brantner, Z. T., Gen. For. M. of W. Shops, B. & O. R. R., Martinsburg, W. Va.
Brewer, W. A., Asst. Engr., C. & N. W. Ry., Clyman, Wis.
Bricker, H. R., Inspr. M. of W., B. & O. R. R., Baltimore, Md.
Burns, W. E., Asst. Engr., Sou. Pac. Co., Portland, Ore.
Clothier, E. E., Chief Carp., C. M. & St. P. Ry., Perry, Iowa.
Connolly, C. G., Gen. For. B. & B., D. L. & W. R. R., Scranton, Pa.
Crites, G. S., Div. Engr., Sou. Pac. Co., Los Angeles, Cal.
Crosman, D. M., Asst. Engr., Sou. Pac. Co., Los Angeles, Cal.
Degnan, L. V., Chief Draftsman, Sou. Pac. Co., Oakland Pier, Cal.
Derr, W. L., Supt., C. G. W. R. R., Clarion, Iowa.
Eastman, J. S., For. B. and B., O. S. L. R. R., Idaho Falls, Idaho.
Edwards, W. R., Asst. Engr. Bridges, B. & O. R. R., Baltimore, Md.
Elder, W. E., Mast. Carp., C. B. & Q. R. R., Burlington, Iowa.
Gaut, J. B. Br. Inspr., G. T. Ry. Montreal, Que.
Gentis, Ira, B. and B. Foreman, Sou. Pac. Co., Oakland, Cal.
Gordon, Guy, For. Water Service, C. R. I. & P. Ry., Little Rock, Ark.
Gureizky, J., For. B. and B., Col. Mid. Ry., Colorado City, Colo.
Harris, C. J., For. B. and B., O. S. L. R. R., Idaho Falls, Idaho.
Henderson, J., Foreman B. and B., G. T. Ry., St. Thomas, Ont.
Hitesman, U. S., Gen. For., N. Y. C. & H. R. R. R., New York City.
James, A. J., Gen. For. B. & B., A. T. & S. F. Ry., Topeka, Kans.
Kibbey, G. S., Asst. Engr., M. & St. L. R. R., Minneapolis, Minn.
Knowles, C. R., Gen. For. Water Works, I. C. R. R., Chicago.
Lane, E. G., Asst. Engr., B. & O. R. R., Baltimore, Md.
Little, J. W., Asst. Supvr. B. & B., L. & N. R. R., Birmingham, Ala.
Long, M. A., Archt., B. & O. R. R., Baltimore, Md.
Mace, B. S., Supt. of Insurance. B. & O. R. R., Baltimore, Md.
Mayer, M. J., Ch. Draftsman, Sou. Pac. Co., San Francisco, Cal.
Moore, E. G., For. Carpenter, B. & O. R. R., Grafton, W. Va.
Murphy, T. J., For. Water Service, Sou. Pac. Co., Oakland, Cal.
Newhall, V. A., Engr., Alberta Interurban Ry., Calgary, Alta.
O'Connor, W. F., Supvr. Bridges, L. I. R. R., Flushing, N. Y.
Plank, D. E., Supvr. B. and B., Pac. Elec. Ry., Los Angeles, Cal.
Pollard, Homer, Bridge Inspr., Sou. Pac. Co., West Oakland, Cal.
Redinger, C. A., Asst. Engr. M. of W., Southern Ry., Charlotte, N. C.
Robinson, A. W., Asst. Engr., O. S. L. R. R., Salt Lake City.
Rose, Norman, Supvr. B. and B., Sou. Pac. Co., Portland, Ore.
Rose, W. M., For. Water Service, Sou. Pac. Co., Sacramento, Cal.
Roy, C. M., Gen. Bridge For., L. & N. R. R., Birmingham, Ala.
Searls, Niles, Gen. Fire Inspector, Sou. Pac. Co., San Francisco, Cal.
Stevens, A. R., For. B. and B., O. S. L. R. R., Salt Lake City, Utah.
Stewart, W. G., Supvr. B. and B., L. & N. R. R., Nashville, Tenn.
Swan, L. W., Supvr. B. and B., L. V. R. R., Easton, Pa.
Thomas, T. E., Mast. Carp., B. & O. R. R., Wilmington, Del.
Wagner, R., Asst. Mast. Carp., C. R. I. & P. Ry., Little Rock, Ark.
Wells, A. A., R. M. and Supr. B. & B., Sou. Ry., Winston-Salem, N. C.
Wells, D. T., For. B. and B., O. S. L. R. R., Salt Lake City, Utah.
Whitney, W. C., Supvr. B. and B., B. & A. R. R., Boston, Mass.

Total number of new members, 54.

Respectfully submitted,

A. H. King,
Chairman.

The secretary was instructed by a vote of the association to cast one ballot for the election of the applicants named, making them members, whereupon they were declared entitled to all the rights and privileges of the association.

A recess was taken to welcome the new members and distributing the badges.

Next in order was the President's address.

PRESIDENT'S ADDRESS.

Gentlemen and Members of the American Railway Bridge & Building Association: This is the twenty-second annual convention of our organization. About 21 years ago the first meeting was held at St. Louis, where the organization was born. There are many things for which this association should be thankful upon coming of age. From the original 60 charter members the flattering increase to over 500 members at this time is a matter of record; the publications issued by the association are examples of a progressive and working organization, which are not only eagerly looked for by its members, but are highly prized by the railroad world at large. However, more than this, from the very beginning this organization has cultivated and fostered a spirit of fraternity and brotherly love among its members; this spirit, through all the years of the existence of this association, has been husbanded and nourished, until today it forms one of our most cherished assets. It is handed down to us by our fathers, so to speak, and we hope that there will never be any other feeling among us; if any rivalry is to exist, let it be one of interest and zeal as to who can do most for the further upbuilding of the association in assisting the committees, in any manner whatever, to bring out the best reports on the subjects assigned.

The duties of a superintendent of bridges and buildings 21 years ago were probably not as varied and complex as those of today, but the founders of this organization had their knotty problems to solve, as we have today; they felt that through an organization of this kind they could better themselves, could help their brother members, and could serve their employers better. Such is our inheritance, and like good stewards it is our duty to improve our talents.

As mentioned before, we have passed the 500 mark in the numerical strength of the association; the increase of members has been particularly gratifying during the past decade as the following figures will show:

Charter membership at first meeting	in	1891—	60
Membership	"	1896—	140
"	"	1901—	171
"	"	1906—	340
"	"	1911—	499

This healthy increase in the membership, while very gratifying, brings to us increased duties and responsibilities. The railway world at large, as well as our employers, are following our actions. If we are true to our calling and if we respect the high examples set for us by our predecessors in the service of our organization, we must strive to do our utmost to bring out the best that is in us; we need it, our co-laborers need it, our organization needs it to accomplish its purpose; we should improve in our work as we increase in numbers.

We are expected to improve in the manner of preparing our reports; we must make the most of the opportunities offered by acting as chairmen on committees; this is an honor conferred and if con-

sistently and honestly attended to will bring its reward in the experience gained through the investigations and compilations necessary to prepare a report, and also in the incalculable benefits that are bestowed upon those are not so favorably connected as some of us. Also the younger men who must gain experience from their elders need our advice and counsel, that they may be enabled to carry forward the great work that has been assigned to us as individuals and as members of our beloved organization.

Every member is expected to do his part, every one can assist. The chairman must receive information from the members if our reports are to be what they should be. When we receive a communication from one of the chairmen requesting information we should furnish it promptly. If we have no experience in that particular line, we should answer the letter and say so. That is the least that we can do. There is a feeling among some of the members that they are not in a position to help in the reports. This is a mistaken idea. I am satisfied that every member has some good idea, some method or way to do a thing better than his neighbor; this idea is what we want. Every one should take part in discussions on the floor of the convention. This is a good way to bring out ideas; we all learn by discussing subjects and our publications become the more valuable.

To those who have given their leisure hours for the benefit of this organization in acting as chairmen of committees or as committee members, or who have in any manner whatever assisted in making this convention a successful one, as I feel it will be, the thanks and appreciation of your officers are expressed.

To close this address, without at least referring to the ladies who have accompanied their husbands and friends to this convention, would be to shut out the sunshine and brightness; it is another of the precious precedents handed down to us and we must acknowledge that the ladies have done their share in cultivating and maintaining the brotherly love and affection existing among the members of this association; we all appreciate their presence at our conventions.

The most painful duty that has fallen to my lot is the announcement that death has again invaded our ranks, calling to their eternal rest A. Amos, H. W. Phillips, Geo. J. Bishop. W. W. Perry and W. T. Powell. The committee on memoirs will appropriately refer to the memory of these departed members in its report.

In conclusion, I desire to express my hearty thanks to our secretary, the chairman and members of committees, and the membership at large, for their hearty co-operation during the past year in handling matters pertaining to the work of this association. I bespeak for my successor in office the most loyal support, so that this organization may grow both numerically and otherwise; let every member help in the work. Only when this is actually done may we be able to accomplish the high ideals set for us by the organizers of the association and the requirements of our membership.

REPORT OF EXECUTIVE COMMITTEE.

A meeting was held on Oct. 19, 1911, at the close of the St. Louis convention at which Messrs. Rettinghouse, Penwell, Eggleston, Killam, Schall and Lichty were present. The secretary was authorized to turn over to Mr. Jutton, chairman of the committee on "Fireproofing Timber Trestles," the funds necessary to carry on a number of tests for fire-resisting paints, said sum not to exceed $100.

The secretary was authorized to have 700 cloth bound volumes and 500 paper bound volumes of the 1911 proceedings printed.

At a meeting held in Chicago, March 20, 1912, Messrs. Schall, Penwell, Hadwen, Fullem, Swenson, Eggleston, Aldrich and Lichty were present. Mr

G. W. Andrews, chairman of the committee on arrangements, reported with reference to the hotel conditions at Baltimore. It was finally decided to hold the twenty-second annual convention at the Emerson hotel, and Mr. Andrews was instructed to make the necessary arrangements.

A meeting of the committee was held at the Emerson hotel, Monday evening, Oct. 14, 1912, at which Messrs Schall, Penwell, Aldrich, Killam, W. O. Eggleston and Lichty were present. Matters were discussed relative to some of the committee reports and to the editing of the proceedings. It was resolved that the association use its influence in urging chairmen of committees to complete their reports in time to enable the secretary to mail out advance copies several weeks prior to the convention.

A meeting was held at the close of the Baltimore convention with Messrs. Killam, Penwell, Aldrich, Jutton, Tanner, Smith and Lichty in attendance.

The secretary was instructed to have 800 copies of the proceedings bound in cloth and 400 copies in paper covers. It was suggested by Mr. Smith that hereafter the membership cards should be made to answer as receipts for dues by making some slight changes in the printing of the cards.

C. A. Lichty,
Secretary.

REPORT OF THE SECRETARY.

Baltimore, Oct. 15, 1912.

To the Officers and Members of the American Railway Bridge and Building Association:

Twelve hundred copies of the 1911 proceedings were issued, 700 with cloth covers and 500 with paper covers. Four numbers of the Bulletin were issued during the year. We now have a membership of about 530. The financial statement is as follows:

FINANCIAL.

RECEIPTS.		
Balance on hand, last report,	$ 683.39	
Fees and dues,	859.00	
Advertisements,	1,210.40	
Sale of books,	16.75	
Badges,	7.75	$2,777.29
EXPENDITURES.		
Stationery and office supplies,	$ 11.90	
Postage,	145.60	
Printing and engraving,	888.78	
Drafting,	53.65	
Editing,	75.00	
Badges,	128.00	
Treasurer's Bond,	7.50	
Stenographer,	138.10	
Committee expenses,	98.78	
Salaries,	600.00	
Expenses Secretary Emeritus,	40.55	
Annual meeting expenses,	91.15	
Telegrams, express and exchange,	9.19	
Miscellaneous,	6.25	$2,294.45
Balance on hand,		$ 482.84

Respectfully submitted,

C. A. Lichty,
Secretary.

REPORT OF THE TREASURER.

To the Officers and Members of the American Railway Bridge and Building Association:

Your treasurer presents the following report for the year ending Oct. 15, 1912:

Balance on hand Oct. 19, 1911,	$1,311.10
Interest,	49.86
Balance on hand, Oct. 15, 1912,	$1,350.96

Respectfully submitted,

J. P. CANTY,
Treasurer.

REPORT OF RELIEF COMMITTEE.

Joliet, Ill., Oct. 12, 1912.

To the Officers and Members of the American Railway Bridge and Building Association:

The committee on relief is pleased to report that during the past year but one application has been received for assistance in securing a position. About 50 circular letters were prepared and sent to members of the association. The applicant now has a temporary position and we anticipate that a permanent position will be secured in a short time.

In connection with the work of this committee, it is suggested that any member of the association who knows of an opening should advise the chairman in order that applicants for positions hereafter may be promptly notified.

Respectfully submitted,

ARTHUR MONTZHEIMER,
Committee.

The President:—The secretary will read a letter of interest to the association. The secretary read the following letter from Mr. John Foreman, one of our life members:

Pottstown, Pa., October 2, 1912.

Mr. F. E. Schall, President American Railway Bridge and Building Association, So. Bethlehem, Pa.

My dear Mr. Schall:

I am in receipt of your kind letter of the 28th ult., extending to me a special invitation to attend the annual convention of the American Railway Bridge and Building Association, which will be held in Baltimore October 15th, 16th and 17th, and in reply, I am obliged to express my regrets as I find that my health which is somewhat impaired at this time, will not permit of my making the trip.

On the 25th of July last, I celebrated the 89th anniversary of my birth and from this you will note that I am of necessity not as active as I was when I used to attend our annual gatherings. I have always enjoyed meeting with the members of the association and I can truthfully say that such meetings gave me more pleasure than any other meetings I ever attended. I have al-

ways found the members congenial and ever ready to make it pleasant for each other and I certainly regret that I am unable to be with them at the meeting to be held this month, notwithstanding it is not very far from my home

I wish you would convey to the members my very best wishes for a pleasant time, and trust the meeting will prove beneficial to each one who is fortunate enough to be there. Tell them that while I am unable to be at the meeting, I shall think of them while they are attending the convention. If you should happen to visit Pottstown I would be pleased to have you call to see me.

Thanking you for the special invitation sent me and with kindest regards, believe me to be,

Sincerely yours,
JOHN FOREMAN.

The president announced that he was prompted by Mr. W. M. Camp to invite Mr. Foreman to attend the meeting and this letter was the result.

It was moved by Mr. Killam that the association acknowledge receipt of Mr. Foreman's letter and that we send him our most hearty greetings. The motion was carried.

The President:—I will appoint the following committees: to audit the accounts of the secretary and treasurer, W. O. Eggleston, R. H. Reid and F. A. Taylor; on selection of subjects, C. E. Smith, A. S. Markley, G. Aldrich, D. C. Zook and R. H. Reid; resolutions, Lee Jutton, R. H. Reid and G. Aldrich.

Mr. Lee Jutton was appointed assistant secretary.

REPORT OF THE AUDITING COMMITTEE.

To the Officers and Members of the American Railway Bridge and Building Association:

The auditing committee has carefully examined the books and accounts of the secretary and the treasurer and finds that the reports, as presented, are correct.

Respectfully submitted,

W. O. EGGLESTON,
R. H. REID,
F. A. TAYLOR,
Committee.

The report of the committee was accepted and ordered placed on file and the committee discharged.

The president announced that the next order of business would be the taking up of the regular subjects for report and discussion. Mr. Lee Jutton, chairman of committee No. 1, was called upon to read his report and to open the discussion. (See report of committee and discussion.)

The president called upon Mr. J. N. Penwell, chairman of committee No. 2, " Derricks and Other Appliances for Handling Material in Supply Yards," to read the report and open the discussion.

At the noon hour adjournment was taken until 1:30 P. M.

AFTERNOON SESSION.

Tuesday, Oct. 15, 1912.

The discussion of Subject No. 2, which had been taken up during the forenoon was resumed and completed. (See report and discussion.)

Subject No. 3 went by default as the committee failed to submit a report.

Subject No. 4, Concrete Tanks, Stand Pipes and Reservoirs, did not appear in pamphlet form. The report was read by Mr. Jutton, assistant secretary, in the absence of the chairman. (See report and discussion.)

Subject No. 5, Best and Most Economical Pumping Engines. was not reported upon.

The chairman of the committee on Subject No. 6, Roofs and Roof Coverings, presented a letter as follows:

Chicago, Oct. 12, 1912.

Gentlemen:

As chairman of committee on Roofs and Roof Coverings I beg to report that there has not been a meeting of the committee this year, and nothing has been accomplished through the medium of correspondence which warrants any modification or change in the report on this subject submitted last year.

Some members at the convention will probably have recommendations to make, but for my part I can say that my experience since the last convention with different types of roofings has still further convinced me that the report submitted last year, particularly regarding the value of the built-up type of roofing as compared with the various prepared roofings should be allowed to stand.

T. J. FULLEM, *Chairman.*

(The subject was not discussed.)

The discussion of Subject No. 7, Reinforced Concrete Culvert Pipe, was opened by Mr. H. H. Decker in the absence of Mr. Hadwen, the chairman. (See report and discussion.)

After discussion of Subject No. 7 adjournment was taken until Wednesday morning.

MORNING SESSION.

Wednesday, Oct. 16, 1912.

President Schall called the convention to order at 9:30 A. M.

Subject No. 8, The Construction and Maintenance of Long Pipe Lines for Locomotive Water Supply, Intakes, Pump Pits, Reservoirs, etc., was read by the secretary in the absence of Mr. B. J. Mustain, the chairman. The discussion of the report followed. (See report and discussion.)

At the conclusion of Subject No. 8 the president read the report of the nominating committee:

REPORT OF THE NOMINATING COMMITTEE.

To the Members of the American Railway Bridge and Building Association:

The committee on nominations begs leave to submit the following list of names for officers of this association for the ensuing year:

President, A. E. Killam, I. C. R. of Canada.
First Vice-President, J. N. Penwell, L. E. & W. R. R.
Second Vice-President, L. D. Hadwen, C. M. & St. P. Ry.
Third Vice-President, T. J. Fullem, I. C. R. R.
Fourth Vice-President, G. Aldrich, N. Y. N. H. & H. R. R.

For members of Executive Committee: G. W. Rear, W. F. Steffens, E. B. Ashby, C. E. Smith, S. C. Tanner, Lee Jutton.

R. H. Reid,
S. F. Patterson,
J. H. Markley,
J. F. Parker,
Committee.

It was announced by the president that according to the constitution the report must lie over until the third day of the convention.

Subject No. 9, Turntables, was next taken up for discussion, which was opened by Mr. C. E. Smith, the chairman. (See report and discussion.)

At 12 o'clock adjournment was taken until afternoon.

AFTERNOON SESSION.

Wednesday, Oct. 16, 1912.

Meeting called to order by the president at 2 P. M.

A telegram was read from Mr. W. A. McGonagle wherein he stated that he was sorry that he could not be in attendance at the convention.

The discussion of turntables was resumed and continued at considerable length until the president ruled that the discussion be closed and that any member having anything further to add should submit it in writing to the secretary.

Subject No. 10, Track Scales,—Construction and Maintenance, was next in order. Upon a suggestion from the American Railway Association it was recommended that a few items be withheld from the report. The report was quite comprehensive but incomplete; it was passed without discussion and recommended to be carried over until next year. A motion to that effect was made and was carried.

The next report in order was No. 11, Painting of Structural Iron or Steel, for Both Bridges and Buildings. The report was read and the discussion opened by the chairman, Mr. Ettinger. At the close of the discussion it was voted to allow Mr. Coleman, a member of the American Society for Testing Materials, of Cleveland, the floor for a few minutes to address the convention on the Theory of Corrosion on Iron and Steel.

The remainder of the afternoon was occupied in the discussion of Subject No. 11, Relative Merits of Brick and Concrete in Railway Buildings and Platforms. In the absence of the chairman, Mr. Hand, the secretary presented the paper and read extracts therefrom.

Adjournment was taken at 5:30 until Thursday morning.

MORNING SESSION.

Thursday, Oct. 17, 1912.

Meeting called to order at 9:30 A. M. by the president.

The report of the obituary committee was presented by the chairman, Mr. J. N. Penwell.

REPORT OF THE OBITUARY COMMITTEE.

To the Members of the American Railway Bridge and Building Association:

Whereas, our Heavenly Father in his divine wisdom has called from our midst, and from this busy life five of our beloved members and friends, thus reminding us of the certainty of death, and the importance of right living, therefore be it

Resolved, That although death is the natural end of man, and all things else, we deeply and sincerely mourn the loss of these faithful members: A. Amos, W. H. Phillips, George J. Bishop, W. W. Perry and W. T. Powell.

Resolved, That the secretary extend to the widows and families of these deceased members the sincere sympathy of our association, and that a copy

of these resolutions be sent to their respective families, and spread upon the minutes and printed in our proceedings.

J. N. PENWELL,
Committee.

REPORT OF THE PUBLICATION COMMITTEE.

To the American Railway Bridge and Building Association:

The committee on publications met several times to assist the secretary in outlining and preparing the work for the proceedings.

We desire to call the attention of our members to the urgent necessity of getting the reports out on time, in order that the association may have the benefit of the printed reports at least several weeks before the annual meeting. This will permit the members to prepare oral discussions or to send in written discussions if they find they will be unable to attend.

We also mention the fact that several new members acted as chairmen of committees during the past year and each filled the position with credit to himself and the association.

We trust that the work of the coming year will be taken up promptly and that the secretary will be given encouragement in getting the work out early.

R. C. SATTLEY,
A. MONTZHEIMER,
LEE JUTTON,
Committee.

The President:—We will next proceed to the election of officers. I will appoint Messrs. Knowles, Pickering and Clark as tellers.

Mr. Pickering:—We have been working rather hard and I know there is no contest here, hence I move that the assistant secretary cast one ballot for the list of officers as presented by the nominating committee.

The motion was seconded and carried unanimously and the assistant secretary cast the ballot.

President Schall:—The time has arrived to install the new officers, but before we begin that, I want to express my appreciation to you for the careful attention and the active work of the year just passed. I hope that you will accord to my successor the same co-operation. Give him all the assistance you can. Work out your reports early, so there will be no anxiety on his part in getting the work moving as it should. Mr. A. E. Killam, you have been elected as president of this association for the ensuing year. Are you willing to accept the office?

Mr. Killam:—I am.

President Schall:—Please step forward. With this gavel, I transfer to you the authority of this office. (Applause.)

President Killam:—Mr. Secretary and fellow laborers in the

Bridge and Building Association of this broad country of ours, and when I say this broad country of ours, I don't refer to any lines, but to the extent of this country from the Gulf of Mexico to the North Pole: This coming year, we have a large field before us and a large amount of work to do. I want to refer to the excellent work done by the committees for the past year. The reports of this year have certainly surpassed anything that we have had heretofore and I trust that the committees we have appointed for the coming year will equal, and if possible will excel, those heretofore.

This association of ours has been very dear to me. I have been now meeting with you for 15 years, and they have been 15 years of pleasure. I have looked forward every year to the time when I should meet the noble faces I see before me at this time in conference for the country's good, because I claim that there is no class of men that have the interests of the great traveling public so much at heart as the men who look after the buildings and the bridges in particular. One can get by a poor building, but he cannot get by a poor bridge. They have to be looked after, and if they are looked after as these men of the association, our brothers in the service, look after them, there will be no danger. It is a work in which I take delight. I have been in bridge work for about 40 years, and I am not tired of it yet.

I will close my remarks by saying that we will undertake to do the very best we can for the public at large and for those who employ us and pay our expenses and wages. Therefore, gentlemen, we will proceed to the closing of this session and we will go home with fond remembrances of the treatment we received from the city of Baltimore.

The other officers were then installed.

The Secretary:—I desire to say that Mr. Killam has earned the promotion which has come to him. He joined the association at Richmond in 1898, which meeting he attended and has not missed a convention since. In all these years he has been active in the work of the association and always performed every duty that was assigned to him. Hence I say that he richly deserves the honor that has been conferred upon him here today, and the association has honored itself in naming him for its next president.

The first meeting which I attended was at Detroit in 1899, and I well remember the active interest that was exercised by

many of our older members, a goodly number of whom are in attendance at this meeting, among them our honored president of that year. I have been in attendance every year since. Our older members are gradually falling off or retiring and the work of conducting the affairs of this association devolves upon those of us who are still active. Much depends upon the newer members and they should make it a point to get interested in the active work as early as possible in order that they may get the benefit of the experience which will come to them in research, as well as the association receiving the benefits of their experiences. There is a vast amount of work to do if we are to make a success of the problems which present themselves for the coming year. If we all assist in the work—no matter how little—it will help.

Your secretary takes much interest in the work which is consigned to him, for if he did not he could not successfully carry it on in connection with his regular vocation. I wish to thank you for the confidence you have reposed in me in electing me to serve another year in this important position and it is my earnest desire that you may not be disappointed in my efforts.

The Secretary:—I find that Mr. Wm. Carmichael, one of our earliest members, who up to a few years ago had always been prompt in payment of dues, had the misfortune several years since to lose a leg and since that time he has fallen behind. Mr. Carmichael is employed by the St. Joseph & Grand Island R. R., at St. Joseph, Mo., in the same office with Mr. O. H. Andrews. I think the association would be justified in remitting his dues and in making him a life member.

Mr. Pickering:—I think that we are but honoring ourselves if we confer that title upon our faithful old members who have become incapacitated. I offer a motion that Mr. Carmichael's dues be remitted and that he be elected a life member. I would like to include in the motion the name of Mr. W. A. Lydston, my predecessor in office. He has been retired from duty on the B. & M. R. R.

The motion was duly seconded and carried.

Mr. G. W. Andrews:—I would like to offer the name of Neil McLean, of the Erie railroad. This is without any solicitation on his part as far as I know. Mr. McLean is now past his seventy-third year, and we all know what that means in railroading. It is only a matter of a very short time until Mr. McLean will have to retire. We hope of course that he will not, but taking the

ordinary and general run of events in railroading, a man who reaches 73 in the service is very remarkable. I offer a motion that Mr. Neil McLean be made a life member of this association. (The motion was seconded and carried.)

Mr. J. H. Markley:—I would like to present the name of Mr. W. M. Noon, one of our retired members, for life membership.

The name of Mr. A. Findley was also presented. Mr. Noon and Mr. Findley were elected life members.

Upon a motion made by Mr. Dupree it was voted that the association provide identification numbers for the ladies who attend future conventions, the numbers to correspond to those worn by their husbands. The secretary was authorized to provide the buttons.

Mr. Dupree brought up the question of changing the time of the annual meeting to the spring of the year, mentioning the fact that it was difficult for many of the members to get away in October when everyone connected with railway work was busy preparing for the winter.

Mr. Pickering called attention to the fact that the constitution states that the convention shall meet each year on the third Tuesday in October, and to bring this matter before the convention in proper form it would be necessary to present the proposition in writing and to give notice to all members at least 60 days prior to the meeting.

The president announced that the next order of business would be the selection of the place to hold the next convention.

Mr. Pickering called to the attention of the older members the fact that nine years ago it was decided that a few members should give Quebec a complimentary vote to show our appreciation, at least to some extent, of the efforts of our friend Killam, who for years pleaded urgently that we "come over" and enjoy genuine Canadian hospitality. The joke turned out to be a reality and the vote was decided in favor of Quebec. Mr. Pickering alluded to the earnest efforts put forth by Mr. Killam that year and described the care with which he arranged every detail which made for the success of that convention and the entertainment of those present,—the most successful of any held up to that time. He spoke of the loyalty of Mr. Killam to this association. He mentioned the fact that Mr. Killam had been in attendance at every convention since he joined, at Rich-

mond, in 1898, and that he had been honored by being chosen president because he deserved it in every respect.

Mr. Pickering then made a motion that we honor Mr. Killam by holding the next convention in Montreal, stating that he was not superstitious at the time when we decided to go to Quebec for the holding of our 13th annual meeting (the year that he himself was president) and he predicted nothing but a successful meeting if we decided to hold the 23rd convention in Montreal in 1913.

The motion was seconded and carried, whereby Montreal received the unanimous vote by acclamation without having a rival, which was perhaps the only instance of like character in the history of the organization.

Mr. Aldrich reported that he had recently met Mr. Cyrus P. Austin, one of our life members, who served several years as treasurer and who wished to be remembered to all of our members in attendance at this convention.

Upon a motion made by Mr. R. H. Reid the secretary was instructed to send to Mr. Austin a letter of greetings conveying the best wishes of those present.

The committee which was appointed to select subjects for report and discussion for next year presented the following:

REPORT OF COMMITTEE ON SUBJECTS.

To the Members of the American Railway Bridge and Building Association:

We submit the following list of questions for report and discussion at our next annual meeting:

1. Water Supply.
2. *Track Scales.
3. Equipment and Tools for Bridge Gangs.
4. Concrete Culverts and Various Kinds of Pipe for Culverts.
5. Heating, Lighting and Ventilating of Round Houses and Shops.
6. Sewers and Drains.
7. Motor Cars for Bridge Gangs.
8. Temporary Structures for Supporting Tracks during construction of Permanent Work, Sewers, etc.
9. Concrete Posts, Poles, Signs, etc.
10. Snow Fences.
11. Preservation of Timber.
12. Cattle Guards.
13. Fire Resisting Coatings for Timber.

(*Carried over from last year.)

C. E. Smith,
A. S. Markley,
G. Aldrich,
D. C. Zook,
R. H. Reid,
Committee.

The president announced that if no further business appeared we would receive the report of the committee on resolutions.

REPORT OF COMMITTEE ON RESOLUTIONS.

To the Members of the American Railway Bridge and Building Association:

The committee on resolutions respectfully submits the following report:

Resolved, that the thanks of the association be extended to Mr. Robert E. Lee, for his address to the members and their friends, and the hearty welcome from the mayor and citizens to our members and others in attendance at our convention;

To the management of the Emerson hotel, for the courteous treatment of the members and their families;

To the representatives of the various railway engineering magazines who reported our proceedings for their several journals;

To the Pullman Company and the various railroads, for courtesies shown our members and their families en route to and from the convention;

To the people of Baltimore, who, through Mr. Anderson Polk furnished entertainment for the ladies at the Country Club;

To the Railway Bridge and Building Supply Men's Association for valuable services rendered in entertaining our members and their friends;

To the Baltimore & Ohio Railroad for furnishing a special train and luncheon to our members and escorting them about the Baltimore terminals;

To the officers and committees, who rendered valuable time and assistance in promoting the welfare of the association during the past year.

R. H. Reid,
G. Aldrich,
Lee Jutton,
Committee.

No further business appearing the meeting adjourned to meet in Montreal the third Tuesday in October, 1913.

G. K. ANDERSON,
Stenographer.

C. A. LICHTY,
Secretary.

MEMOIR.

Alexander Amos died at his residence, 1023 28th Ave., N. E., Minneapolis, March 17, 1912, at the age of 71 years, 8 months and 16 days.

He entered the army in the 142nd regiment of New York and served two years and nine months, being discharged as first lieutenant, on Feb. 17, 1865. He then located at Norwood, N. Y., as a mechanic. In 1879 he went to Minnesota and entered the service of the Chicago, Milwaukee & St. Paul Ry., as general foreman of bridges and buildings of the Southern Minnesota Division.

ALEXANDER AMOS.

He became superintendent of bridges and buildings of the Minneapolis, St. Paul & Sault Sainte Marie R. R., in 1886, which position he held until two years ago when he was pensioned on account of having reached the age limit.

Mr. Amos is survived by a wife and three sons, Oscar, William and Merton. He expired suddenly while retiring for the evening.

Funeral services were held at Minneapolis March 18, and the body was sent to Norwood, N. Y., where Mr. Amos was born, for interment.

Mr. Amos joined the association in 1902 and was elected a life member in 1910.

MEMOIR.

George J. Bishop was born Dec. 4, 1851, at White Haven, Pa. He left school at the age of 14 to work in the pine forests and saw mills of the upper Lehigh region of Pennsylvania. He worked in the bridge and building department of the Lehigh Valley R. R. as a carpenter from 1869 to 1871. Following this he worked for several years as a carpenter and as carpenter foreman for various contractors on buildings and coal breakers in the anthracite coal regions of Pennsylvania.

GEORGE J. BISHOP.

In the year 1877 he went west and began as a building carpenter foreman on the Hannibal & St. Joseph R. R. where he remained until 1879, when he entered the service of the Denver & Rio Grande as foreman, soon being promoted to the position of superintendent of bridges and buildings. He held this position until 1883 when he went with the Union Pacific R. R. as foreman and general foreman of bridges and buildings, remaining with this road until April, 1887 From this time until 1903 he was engaged with the C. K. & N., now a part of the Rock Island System. He was then made master of bridges and buildings of the Grand Trunk at Durand, Mich., remaining here until 1906.

Upon leaving the Grand Trunk Mr. Bishop followed contract work for about a year and then entered the service of the San Antonio & Aransas Pass Ry., at Yoakum, Texas, as timber inspector, which position he held at the time of his death which occurred July 17, 1912, at Bayou Sale, La., from acute indigestion His body was taken to Wilkes Barre, Pa., where it was interred in the family plot in the Hollenback cemetery.

Mr. Bishop was an active member of this association having joined at Philadelphia in the year 1893.

MEMOIR.

Henry W. Phillips was born at Fall River, Mass., March 13, 1840. His death occurred May 9, 1912, at Harwich, Mass., resulting from a stroke of apoplexy. He began railroad work in 1866 as bridge carpenter on the Old Colony railroad, which later became a part of the New York, New Haven & Hartford railroad. In 1880 he was appointed to the position of foreman of bridges and buildings on the Cape Cod division with headquarters at Hyannis, Mass., and was again in 1880 promoted to the position of supervisor of

W. L. PHILLIPS.

bridges on the Cape Cod and Plymouth divisions, in which capacity he served until he was retired on a pension in April, 1908.

Mr. Phillips was a man of noble character and was highly respected by all with whom he came in contact. The vast throng of railroad men which was assembled at his funeral service gave silent evidence of the esteem in which he was held by those with whom he was associated for so many years.

He is survived by a wife and one son, Henry A. Phillips, who holds the position of district foreman of bridges and buildings at Buzzard's Bay, Mass.

Mr. Phillips became a member of this association in 1903 and was elected to life membership at the annual convention at Washington, D. C., in 1908.

MEMOIR.

William T. Powell was born at Hancock's Bridge, N. J., Nov. 25, 1857, and died at his home in Denver, Colorado, September 30, 1912, after an illness of several months.

When Mr. Powell was 12 years old he left New Jersey and went west with his parents. He worked with his father and brothers on their farm in Iowa until 1882, when he went to Colorado and prospected for two years in the Rocky Mountains. He made his home in Colorado from this time until his death.

Mr. Powell began his railroad career in 1884 with the Union Pacific R. R. as bridge carpenter, being later promoted to foreman on the Denver, South

W. T. POWELL.

Park & Pacific branch of that road. In 1885 he left the Union Pacific and accepted a position as foreman on the Denver, Leadville & Gunnison, working for that company until it went out of existence in 1889, at which time he entered the employment of the Colorado & Southern as bridge carpenter and held that position until he was promoted to foreman. After a few years of faithful service as foreman he was appointed inspector on the same road. In 1902 he was promoted to the position of general foreman. When Mr. O. J. Travis (the founder of this association) retired from the office of superintendent of bridges and buildings, in 1906, Mr. Powell was appointed to fill the office, which position he held at the time of his death.

Mr. Powell was married July 24, 1890, to Miss Bee Smith and is survived by his wife and two daughters, Lillian and Martha.

Mr. Powell became a member of the association in 1901 and attended several of the recent conventions. He had a strong personality, was honored in his private life and was trusted and respected by all his employes, in fact, by all who knew him. The beautiful floral offerings and the large attendance at the last sad rites told how much he will be missed by all his friends, but most of all by his family.

MEMOIR.

W. W. Perry was born Feb. 20, 1837, in Montour Co., Pa., and died at Williamsport, Pa., Aug. 16, 1912. Death was due to acute indigestion from which he had been suffering for some ten days during all of which time he was in an extremely critical condition.

Mr. Perry entered railroad service as a chainman with the engineer corps of the Catawissa, Williamsport & Erie Railroad in Oct., 1853, and served until the completion of the road in July, 1854. He was re-employed as foreman carpenter with the same company, Aug. 1, 1864, promoted to

WILLIAM W. PERRY.

master carpenter, Jan 1, 1867, and master carpenter of the Shamokin division, May 1, 1889 During his service as master carpenter on the C. & W. branch he also held the position of roadmaster and division engineer in charge of roadway and track. It may be said of him that during a portion of this time he was the defacto superintendent

During his long career of more than 48 years of railroad service, he made a multitude of friends, both among officials and subordinates, because his sterling uprightness of character and superior ability in his profession commanded the respect and admiration of all

He was a veritable giant in emergencies, a fact that was amply proven by his brilliant work during the floods of 1889 and 1890 when the Muncy and Sunbury bridges were swept away. He not only executed work of the first order in his department of bridges and buildings, but was a designer of some note as well.

Mr. Perry was retired on a pension Dec. 31, 1911. He was a member of the Masonic fraternity and of the Pine Street M. E. church, at Williamsport,

of which congregation he was one of the stewards. He is survived by his wife and two daughters, one of whom, Miss Sara Perry, resides at home, the other one being Mrs. Lewis Baker, of Tamaqua; also by three brothers, Thomas and Joseph, living at Mooresburg, Pa., and Robert W. Perry, a lumberman in Mississippi, and a sister, Mrs. Mary Budeman, residing in Delavan, Ill.

Deceased joined the association in 1904 and was elected a life member at St. Louis in 1911. He was a regular attendant at the conventions in which he took an active interest. His wise counsel will be missed in future meetings.

Subject No. 1.

FIRE RESISTING COATINGS FOR TIMBER.

REPORT OF COMMITTEE.

The work of this committee for the past year is a continuation of the study outlined in the report submitted to the St. Louis convention last year, Fireproofing for Timber Trestles, and, as instructed by the association, consists of tests of different kinds of fire resisting paints when applied to timber bridges. During the early part of the past summer it was found that this work could not be completed in time to make a final report to this convention. It was therefore decided, with the consent of the president, to get as much as possible done and to make a progress report at this time and a final report to the 1913 convention.

Up to this time we have erected ten test structures, each eight ft. long and about four ft. high, at West Chicago, on the Chicago & Northwestern Ry. The timber for these tests was donated by the Chicago & Northwestern Ry. No paint has been applied to these structures as yet, but this will be done the latter part of this month. They will then stand through the winter and the fire tests will be made in May of June, 1913.

Inquiries have been made of 88 concerns manufacturing paints, each of which was asked if it made a fire resisting paint, and if so if it desired to have its paint tested and a report made to our association as to its merits. As a result of this inquiry 18 concerns sent samples for the test.

No doubt many of our members have done considerable painting of pile bridges and we would like to hear from them with reference to the manner of applying the paint to the different parts, especially as to getting the paint between the stringers, where the space between them is only about four inches.

Lee Jutton,
W. H. Moore,
Committee.

DISCUSSION.

Mr. Jutton:—In the discussion of this progress report I would like to get some idea of the method of procedure in applying the fire test. Of course, we want to approach as nearly as possible the conditions which we have to contend with in actual service, but at the same time we want to have more severe tests than that. I have not decided yet just how we will go about it and I think that this will be a good subject for discussion.

The President:—We will be glad to have this subject discussed by all the members, to bring out the best method for applying this paint and conducting the tests. We will be glad to hear from any of the members.

Mr. A. S. Markley:—I presume it is the intention to have a separate structure for each kind of paint?

Mr. Jutton:—As I said, we have about 18 samples of paint and only 10 dummy structures erected. I hardly think it will be necessary to erect a separate structure for each paint. I think we can apply at least two paints to one structure, one kind of paint at one end and another at the other end, so that they will meet half-way on the stringers and ties. When we set them afire if one is weak and the other strong, that part covered with the better paint will possibly be saved. If anyone sees any objection to applying the paint in this way, we would be glad to hear it.

Mr. A. S. Markley:—I believe there should be a structure for each kind of paint. Each man who owns or controls a paint should be allowed to paint the structure, and, if it burns, it is up to him. He can apply the paint just as he desires.

Mr. Jutton:—It would be rather difficult to get a workman there from each concern, but I am impressing upon the manufacturers that they should give us all the specifications they have.

Mr. A. S. Markley:—They could employ a man to put the paint on and let us keep clear of it. We are the disinterested ones; let the interested ones apply the paint.

The Secretary:—This association is having these tests made and the different kinds of paint should all be applied by the same workmen just as would be done in actual practice. If a manufacturer sent a representative there, he might alter the paint or the process in a way that we might not do if we applied it ourselves. If they give us the paint and we apply it according to their instructions or directions, it will coincide with what we will have to do in practice. We have the men there to do the work and I think it would be far more satisfactory to proceed in that manner. Some of those firms are located a thousand miles away, and they might not want to send a representative to apply the paint to these small structures; I do not think we should allow them to do it, as it would not be fair to the association when it is making these tests.

Mr. A. S. Markley:—If the manufacturers want to apply the paint and desire to alter it to keep it from burning, let them

alter it. We don't care if they do change it. If it won't burn, it's the material we want. As far as their being a thousand miles away, give them the name of a painter and let them employ him to apply the paint.

Mr. Ettinger:—I have had quite a bit of experience with tests of this nature and I have found that if tests are to be satisfactory to us and to the manufacturers the paints should be used under the same conditions that we use them every day. If we do not do that, we create a special condition. We are not working under special conditions, but under average conditions, and we ought to apply the paint in the same way. If the manufacturer wishes to, let him send a representative. Notify him that we are going to be ready at a certain time and if he wants to see that he gets fair treatment let him be there.

Mr. Penwell:—I have been wondering if it is really a fair test to ask the manufacturer to send us the paint. I think we should buy the paint on the market and apply it ourselves without the knowledge of the manufacturer. Without accusing any manufacturer of unfairness, it would be unfair to allow them to send us the samples, make our tests from the samples and then go into the market and buy the paint for use. We have no absolute guarantee that we are getting paint similar to the sample furnished us. A safer and more practical test would be to buy a gallon or two gallons of paint in the market and then apply it without asking the manufacturer anything about it. Then we would have just such paint, applied in just such a manner as we would apply it if we were using it for fire protection.

Mr. C. E. Smith:—I do not think there is any objection to getting the paint direct from the manufacturer, but I think it should be applied by the bridge men as Mr. Jutton proposes, because it will then be applied in a manner similar to the conditions under which it will be applied in practice.

Mr. Penwell:—It would be all right where we have the formula given so that we can have the paint analyzed and find out if we are getting what we specified; but in this case, we have no formula, as I understand it.

Mr. Jutton:—Even though we buy the paint on the market, we have no guarantee that that paint—say we did find one that we considered first class—would be kept up to that standard. We have received samples within a month or so after I wrote to the manufacturers, and I don't believe that they had time

to get up a special production for our tests. If they did, and did send us something which is the best they have and which is found to be a good paint, we have reason to believe that that is what we would get from them on orders. No matter how we get it, whether we buy it or ask for it, there is no reason to believe that the manufacturers may keep it up to that standard. They may do it and they may not.

Mr. Penwell:—If we buy the paint on the market and decide that a certain paint is the best and is the paint we ought to use, our chief chemist can analyze it and then we can determine by analysis whether it is the same paint we are getting in the future.

Mr. Ettinger:—This is not a paint problem in the common sense of the word and should not be so classed, but it is a fire-proofing study and some firms are making a specialty of that, perhaps making no other kind of paint. The formulas are something they possess and never will give up to us unless our chemists can find them, and I am of the opinion that no chemist can find the correct formula for them. If they sell this paint to us, their reputation is at stake.

Mr. Sheldon:—It seems to me that for a comparative test of the qualities of fire-resisting paint, some sections or parts should be left unprotected or untreated in any way, and the same test applied to those parts to get a comparative test between untreated timber and treated timber. If we do that, we will know whether any of the fireproof paints are good or not. In that way we can get at the fire-resisting qualities of most of the paints.

Mr. Jutton:—How would it be to leave a little section untreated?

Mr. Sheldon:—That would be my idea exactly, to leave part untreated and note the result.

Mr. A. S. Markley:—Which would you start the fire on first?

Mr. Sheldon:—All at the same time.

Mr. Ettinger:—We have made a test of that kind. I am afraid the untreated structure will catch fire and you will have trouble on your hands.

Mr. Penwell:—As I remarked in the St. Louis convention, along with the other samples that we propose to use, I hope we will try whitewash at the same time and see whether we want to buy any paint or not.

Mr. Pickering:—It seems to me that the idea advanced by quite a number has been the fair one, that our committee should

be authorized to go into the open market and purchase samples of each of these different makes of fireproofing paint and to apply them under conditions similar to those existing when we purchase the paint to apply it on our bridges. That gives each manufacturer an equal chance and gives us a guarantee that we are getting the market article and not some special paint that the manufacturer has provided to test. Therefore, if it be in order, I would move you that our committee be authorized to purchase a sufficient quantity of the various makes of fire-resisting paints and to apply them to these structures.

Mr. Penwell:—I second the motion.

(The chairman then stated the motion.)

Mr. Knowles:—Is this paint to be purchased in the open market? As I understand, a great deal of it can only be purchased from the manufacturers.

The President:—From the manufacturers or in the open market, as I understand the motion.

(Motion carried.)

Mr. A. S. Markley:—I wish to settle the question as to whether we are to have one structure for each kind of paint, or have two kinds of paint on the same structure. If we have two kinds on the same structure and one starts to burn and heats the other up, the latter is going to catch fire quicker than it otherwise would.

Mr. Jutton:—If it is fire-resisting, it ought not to burn.

Mr. A. S. Markley:—You cannot expect to get paint that will not burn at all. It is the paint that resists the longest that we want to recommend.

Mr. Pickering:—I would like to ask the committee how many different brands of paint they propose to test?

Mr. Jutton:—We already have on hand 18 kinds and we have ten test structures. If we are to apply one type of paint to each structure, we will have to put up a few more. We can do that all right.

Mr. Pickering:—Do you use second-hand timber?

Mr. Jutton:—Yes.

Mr. A. S. Markley:—How are you going to ignite the trestle in these tests?

The President:—That was a particular point the chairman wanted to bring out.

Mr. Killam:—I doubt whether anyone has ever seen a new

structure take fire from coals dropped from a locomotive, but it is always a structure that has more or less rotten wood in it. If you put on enough paint to fill all these rotten places this will aid in extending the life of the bridge and preventing fire, but you are not accomplishing anything when you put this paint on new timber, because the ordinary new bridge will not catch fire from a locomotive dropping coals when going over it.

Mr. Pickering:—I shall have to disagree with Mr. Killam on that. I have had fires on bridges within six months where the timber was practically new; also on bridges which had been build not over two years at the outside. It is a fact that some of these fire-resisting paints are preservatives as well as a protection against fire.

The President:—Is there anything more on this subject? We would like to have someone suggest a method for applying those samples.

Mr. Sheldon:—I would suggest that the committee formulate a method. They should use their judgment in the matter and give us a report of what they do.

Subject No. 2

DERRICKS AND OTHER APPLIANCES FOR HANDLING MATERIAL IN SUPPLY YARDS.

REPORT OF COMMITTEE.

After it was decided to carry this subject over from last year the committee sent one hundred letters to the various roads, asking for information concerning the extent to which derricks were used in supply yards. Fifteen replies were received to this letter. These replies, together with 31 received in reply to a circular sent out last year, were classified as follows:

15 roads report using no derricks of any description.

6 roads report that the store department handles all material, shipping it directly to each piece of work.

7 roads report using no derricks except steam wrecking derricks which are employed for loading heavy material.

8 roads report using steam derricks of various kinds made by several prominent manufacturers which operate under their own power.

6 roads report using derricks of various kinds built by their own forces.

1 road reports the use of an electric traveling crane.

2 roads report using common stationary derricks similar to the stone derrick with booms of sufficient length to reach one track on each side.

1 road reports using an ordinary stiff-leg derrick for handling heavy material.

The use of derricks and other appliances for handling material is divided in two groups; one for supply yards and the other for work of various kinds out on the road. The subject assigned to this committee limits its investigation to the first group and the application of such devices outside of supply yards is not considered here, although it is difficult in many cases to draw a dividing line between the two and a more complete report could have been obtained had the committee been allowed to discuss the entire subject. In many cases it is difficult to draw a line between the use of a derrick for the two classes of work, for a design is frequently used intermittently for both kinds of work and its adaptability for one may govern its selection, although it may possess certain disadvantages when applied to the other work. Bridge derricks can be used to good advantage in yards when not in service on the road, but as they are very often unavailable when required for yard work, they do not fill the requirements for this purpose.

The advantages of a derrick car and the kind of car most suited for any particular work, depend primarily upon the amount and kind of material to be handled. Where but a few cars of material are handled annually, it is not advisable to go to much expense to install the equipment unless the proportion of heavy material is large, in which case a stationary stiff-leg derrick may be advisable. However, as the amount of material becomes greater, the advantages of a derrick increase rapidly and the committee is strongly of the opinion that derricks of some type can be used with economy in a large number of yards where they are not so used today.

A derrick with four or five men will handle as much material as three times that number of men without such assistance, and in less time. Labor is becoming scarcer and more expensive each year. The use of proper

equipment will not only reduce the number of men required but will lighten their work and enable the foreman to secure better men for the money invested. The use of the less number of men in this work permits them to be employed in other gangs, in this way relieving to a limited extent the difficulties in securing men. Also, in handling heavy materials by hand the risk of injury to men is great and this risk will increase as the foreign labor becomes more generally employed in material yards.

Another important advantage with the use of derrick cars is the greater speed in unloading material. This is of advantage in releasing cars more promptly, which in itself is frequently an important item in times of car shortage as at the present time. The accumulation of demurrage charges is also to be avoided where much lumber, cement, iron pipe, etc.. come in foreign cars. This time element is of special importance in loading large quantities of material which are frequently needed for construction work, or in emergencies such as washouts and wrecks. In such times, every hour saved is very important and proper facilities and equipment for handling material will expedite work greatly.

The type of derrick to be used is largely one of individual choice and depends upon the kind of material to be handled. Where very large quantities of material are handled, a traveling electric crane may be advisable. For yards of lesser importance, self-propelled steam derricks with booms of sufficient length to unload material from the car in advance of the derrick on the same track, and to pile materials for some distance on either side. may be advisable. A self-propelling car possesses the advantage that it can spot cars where wanted and then unload the material without requiring the attention of a switch engine, the latter usually resulting in more or less delay and being very expensive. Where a yard is not of sufficient importance to justify the expense of the above equipment, home-made derricks constructed of material on hand are frequently advisable. Derricks similar to the stone derrick with booms 30 or 40 feet long are recommended where much heavy material is to be handled.

Where stationary derricks are used, tramways should be built at right angles with the track to enable men to distribute lighter material out of reach of the derrick, leaving the space within reach for the storage of heavier material.

The committee has not been able to secure data relative to the cost of handling material, but from the letters received, it is estimated that the cost of handling heavy timber, iron and concrete pipe, etc., can be reduced 50 per cent by the use of proper equipment. Lighter material can also be handled at a saving of from 10 to 25 per cent.

J. N. Penwell,
A. S. Markley,
A. Yappen,
D. B. Taylor,
E. A. Stanley,
Committee.

DISCUSSION.

Mr. Penwell:—In the replies received to the circular letter the inclination has been to confuse bridge derricks and yard derricks, in about 75 per cent of the letters. As I understand it, the purpose of the subject was to study methods of handling material in the yard. Some yards depend on mounted bridge derricks to do most of this work. Our bridge derricks are out on the road perhaps three-fourths of the time, leaving the yard

unequipped for handling material in case of emergency, such as fires or wash-outs, when it is wanted quickly. There seems to be an inclination on many roads to transfer the handling of the material to the store department. On some roads the store department handles it exclusively.

The President:—Gentlemen, you have heard what Mr. Penwell has to say in regard to the report on Subject No. 2. I think the last four paragraphs on the second page were intended to be the committee's conclusion, although it does not say so.

Mr. Penwell:—That is the idea.

President:—Gentlemen, I would like to hear what you have to say in the matter of handling bridge timbers in the yard.

Mr. A. S. Markley:—Our main material yard is located at the same point where our general storekeeper is located. We have a derrick car with a double 7 in. x 10 in. cylinder, which is practically an Industrial pile driver without the leads, with a mast and boom put on it, the boom being about 34 or 36 ft. long. Originally it was chain-driven, but we had a great deal of trouble with the chains wearing and getting on top of the sprockets, so changed it to shaft-driven. It is self-propelling and will handle five and six cars on a level so that we can do our own switching. We handle material for $0.35 per M. I do not mean that we load one piece of timber for this figure, but this figure is secured by combining our work with that of the storekeeper, not by ourselves. When we are not using the derrick he is using it. I am confident that stringers, ties and large material can be handled for $0.25 per M. Many times when we want a rush order out on the road, three men will take the derrick and load the material we want. If we did not have the derrick, we might have to call in an entire gang, a distance, sometimes, of 100 miles or more, and in some cases it would take them two days to make the round trip. In seasonable weather the engine is fired up all the time and during the past year it has been in constant service. When we are not using it the storekeeper has it in use.

Mr. Pickering:—I would like to ask Mr. Markley the approximate amount of timber he handles per year with their derrick car in that manner.

Mr. A. S. Markley:—I do not have this figure. We kept a record of about seven or eight months and found the expense to be $0.35 per M. But you cannot handle or unload timber short of $1.50 or $2.00 and up to $5.00 per M. where you have to bring

a gang of men in from the road. We have a house carpenter and two roustabouts in our gang. We take the roustabouts out to handle the timber, and the engineer is responsible for the machine. We have a bed, a stove and a place to cook in our pilot car. The engineer lives here and takes care of the machine in transit.

Mr. Wenner:—Last week I had occasion to use one of these Industrial machines an entire day. I was unloading telegraph poles and the question has been raised of what it would cost to handle bridge material. I had six men with me and while I was crowded for time when I did this, I unloaded 48 pieces of 8 x 16, 24-ft. yellow pine in 30 minutes with that machine, and I picked up 30 pieces of second-hand material of the same size in 20 minutes. I think that the assertion Mr. Markley made regarding unloading or loading material for $0.25 per M. can be realized with a machine of that class, especially if one made it an entire day's work.

Mr. Pickering:—I am much interested in the question of handling material in supply yards. It is quite a problem with me. My yard, where the chief amount of my material is stored, is quite limited, and it is frequently necessary to pile the material very high. Possibly I use more material than a good many of these gentlemen do, because we have many wooden bridges. My requirements for the year 1913 are something over a million feet of hard pine on between six and eight hundred miles. The majority of this material is handled from one yard that is restricted in area. We have three derrick cars on the division and our aim is to keep one of these at headquarters all the time, but we find that it is impossible to do that as there is so much work. The division engineer has quite a bit of work which requires one of these derricks a good deal of the time, and it often happens that we have a vast amount of material coming in and at the same time we have got to ship some out. It is quite a question with us to handle our material economically in the yard.

Mr. Alexander:—We have a ditching machine made at St. Paul, Minn., which is a very good machine for many classes of work. We use that sometimes in our material yard, but we also have a Syracuse pile-driver with an improvised boom with which we have loaded much timber and which does the work well. However, as a general rule, we have nothing in our supply yard for loading timber, except a stiff-legged derrick or something

of that kind. Ordinarily, we store our supplies at different junction points over the road and it pays us better to do the loading with a few section men than to run a machine there and pay a train crew. This may not be logical, but it has seemed so with us.

The President:—Is there anything further on the subject?

Mr. C. H. Eggers:—On the Arkansas Division of the Rock Island we have seventeen miles of bridges. It is very seldom that we drive less than 1,500 piles a year and from that up to as high as 8,000 and 10,000 piles. In connection with our pile driver, we also have a pilot car with a derrick on it. We use the same engine we use on the pile-driver to pick up our timber and unload it. The store department handles the material in the yard altogether. They have a derrick car in the yard and can stack the material as high as they want to or handle any amount of it. I am now building another derrick car independent of a pile-driver altogether, for installing light iron work and other purposes for which it may be required. I think a derrick car is the only way to handle timber successfully.

Mr. P. Aagaard:—Supplies in our store yards are handled by the store department, mostly with cranes. We have, however, a small derrick connected with a locomotive which we use in some of our yards for picking up material.

Mr. C. E. Smith:—Great economy in the handling of material in supply yards can be shown by the use of a self-propelling locomotive crane. Such a crane, with a capacity of 10 or 15 tons and a 40-ft. boom, can be purchased for $5,000 or $6,000 and can handle anything in high piles and for a considerable distance from the track. It will also facilitate the loading of material in station order, which is done on many railroads. Where any special kind of material such as ties, bridge timber or track material, is to be handled, a self-propelling locomotive crane is a very good investment.

Mr. Staten:—It seems as though all those who have spoken have yards where they unload all their material and then ship it out again. On our road, we order it shipped where it belongs, and it is sent there directly from the mill. We keep very little material of any kind in the yard, and don't have much use for a derrick there. The emergency material is distributed along the road at the junction points. If we have a burn-out or similar trouble we load the material from the nearest junction point.

Mr. Smith:—I would like to suggest that the unloading and handling of material on the line as differentiated from handling it in the supply yard might be a good subject for a committee report next year.

Mr. Pickering:—I would like to say one word more about unloading and loading material in the supply yard. What Mr. Markley has said in regard to his material being shipped him is largely true with us, only we may get half a dozen cars today, and on each one of those cars will be all of the different sizes of material we have ordered, from two inch plank to 12 in. or 16 in. timbers. Then again, Mr. Staten lives down South where people are honest, but if we should distribute our material that way along our line, when we came to use it, there would be but little of it there.

Mr. Andrews:—It seems to me that we are straying away from the subject. As I understand this subject, it is one of handling material in the yard economically, not whether we store it along the line or keep it all in one yard. The best way to handle material must be governed in all cases by the local conditions at the yard and the amount of money that a railroad will permit one to spend in installing appliances for properly handling his material. In a great many places skids are erected out of old timber, on the level of the car floor, so that the bottom layer of the timber is always on a level with the floor. One can put up a stiff-leg derrick which in many ways is economical, but one must have an extra track for his cars, because unless it is placed high the stiff-leg derrick will not reach over the cars. A guy derrick with a long boom is practically on the same principle, but is a little more expensive and takes up more space on account of the placing of the guys. Frames with differential blocks are excellent and one can build them out of old railroad iron and old timber. Where the money will permit derrick cranes are excellent, but in my opinion, the most valuable of all is the self-propelling locomotive crane with a long boom which will place piles anywhere in the yard, pick up material from either side of the track and place it in the car in almost any position. A gentleman has said that those cars can be purchased for approximately $6,000. The interest on $6,000, with repairs, will probably run up to $600 annually. If one has a large amount of material to handle, it is a very easy matter to save $600. If he can show his general officers where he can save that amount of money and bring them a profit,

he will get the crane, but unless he can do so, he will not get it. You can use a locomotive crane for various purposes. For handling scrap, one can have it equipped with a generator at a slight expense, put magnets on it and pick up tons of scrap at a price that will be surprising. It is equally available for loading rails, pipe, and similar material around the yard. One can also run it into a freight yard close by and load merchantable material with it as we do in a number of cases. I simply mention the many methods that can be used and are used. All of those methods I mentioned are used on our road and in addition, we use them where we use main strength and awkwardness. I have tried to mention all the ways we handle material, not recommending any of them. The question resolves itself into what is the best method? That is what we want to get at and can be brought out best in the discussion if we confine ourselves strictly to the subject.

Mr. J. F. Parker:—I think that Mr. Markley brought out the right idea. The object we are aiming at is to find the best and the cheapest methods. We can all tell the story of how we do this work but if we do not give the cost of handling material by locomotive crane or of handling it by hand, we are not giving information that is going to be of any value. On the division where I am located, we have two locomotive cranes with 50-ft. booms. I think they were made by the Bay City Industrial Works. These cranes are used for all purposes, such as handling wooden bridge material, car wheels, and other material about the yards and shops that has to be loaded and unloaded. Also, at San Diego Bay we have a large material yard for ties and bridge timber. This material comes in by the cargo. We have steamers coming from Japan that carry a quarter of a million ties and they are all handled by the locomotive crane in the yard.

Mr. McNab:—On the Pere Marquette, we make an annual requisition every fall for the bridge material and piles we want for the next year, amounting to about 300,000 ft. per year. I have a yard at Waverly and when the material comes in, I keep two men there all the time loading and unloading it. When it arrives it is of course all mixed up. I have different skidways on a level with the cars, on which the material is unloaded. As it is required it is loaded and goes out on the road. We are not allowed to distribute material before the men are there to use it, on account of fires. I have always found it practically as

cheap as any other plan, to keep two men in the yard loading and unloading material.

The President:—Gentlemen, it appears to me that we have brought out about all the valuable information we can on this subject. We will pass on and I will ask you now what is to be done with this report? Shall we receive it as information, or shall we turn it back to the committee for enlargement? The committee has not made a distinct recommendation as to what is best under certain conditions. I think they ought to do so as that is part of the work.

Mr. Reid:—I don't think it is necessary for the committee to make a recommendation. I think, as Mr. Andrews said, that the method of handling material and the appliances for handling it will depend largely on the conditions in the various yards. The report has been turned in and printed and in that way has been received and has been discussed here. It seems to me the next thing to do, is to simply proceed with the consideration of the next report. I don't think it is necessary to take any final action on this report at all.

SUBJECT No. 4.

CONCRETE TANK CONSTRUCTION.

REPORT OF COMMITTEE.

In its 1911 report the committee attempted to show what had been done up to that time in this particular field of concrete construction and to determine whether or not the concrete tank was practical and could be recommended for railway service. Examples of tanks built for railway and other purposes were given; specifications were quoted either wholly or in part, and it was shown that the concrete tank is practical and desirable where a permanent tank is contemplated. It is becoming more common to place the tank farther away from the tracks at railway water stations and to deliver water to engines through pipe lines and stand-pipes, thereby making the water tank a more permanent structure. This decreases the necessity for a structure that can be moved on account of track changes and make the concrete tank possible.

The two great arguments in favor of the concrete tank are permanence and minimum cost of maintenance. When the life of the tank is taken into consideration the latter will more than offset the increased cost of construction. The concrete tank is more costly than the wooden or steel tank but the steady increase in the price of lumber and the more improved methods of concrete construction are steadily reducing the difference.

The committee is of the opinion that when subjected to the severest winter weather the concrete tank will stand up better than tanks of other materials. The above statement is based on conversations with various engineers who have had experience in water supply, and at present cannot be substantiated by facts. However, some concrete tanks are located where they are subjected to severe freezing weather and others are being considered so that it will not be long before this point can be determined definitely.

Many arguments are advanced against the concrete tank, the chief one being that poor workmanship will result in a defective tank and this cannot readily be discovered or remedied. The statement is true, but it is also true of all other forms of construction. The remedy is careful, conscientious and competent supervision in selecting materials and doing the work.

DESIGN.

When contemplating the building of a concrete tank the design must first be decided upon. As this association is more directly concerned in the construction work we will simply refer to the 1912 report of the American Railway Engineering Association, in which the subject of design and specifications is very completely covered.

Tanks may be divided into three classes:

(*a*) A hollow cylinder of which the base forms the floor, either resting on the ground or under the surface of the ground. To this class belong large tanks or reservoirs for conserving large quantities of water and those located on elevated places.

(*b*) A hollow cylinder, rather tall and having a diaphragm some distance above the ground surface which forms the floor of the water reser-

voir. The lower portion of the cylinder forms the tower and the enclosed space can be utilized for pumping machinery or for storage purposes.

(*c*) Elevated tanks on towers. As a rule a circular tank is decided on because the stresses are more easily provided for, but there are cases where for local or other reasons it is necessary to adopt square or oblong designs.

Material.

There is no line of work in the broad field of concrete construction in which the care and judgment used in the selection and application of the materials is of more importance than in tank construction. Only cement of approved brands should be used. It should be delivered on the job in original packages and each consignment should be carefully tested. The sand, gravel and crushed stone must be carefully examined for impurities, and all such containing impurities must be rejected. The sizes of the various materials should be carefully considered and the proportions to be used determined in order that the resulting concrete will be as dense and watertight as possible. Much has been written of this particular feature in connection with concrete work in general, therefore, it is not necessary for the committee to elaborate upon it. Our purpose is to emphasize good workmanship.

Mixture.

There seems to be a wide difference of opinion regarding the kind of a mixture that will produce the most compact and impervious concrete. Most specifications call for a wet mixture, yet occasionally a dry mixture is specified. In regard to the latter, Mr. L. Heidenreich says in his Engineer's Pocket-Book of Reinforced Concrete, "The author prefers for tanks a rather dry mixture of one part cement to four parts coarse sand well tamped. If a wet mixture is used the mortar or concrete is apt to contract in setting, thereby causing initial compressive stresses in the steel reinforcement. When the tank is filled the concrete will crack in various places until the steel receives its tension stress. This is the common cause of leaky tanks, which must be plastered or painted afterwards." The decision as to what is best must be left to the engineer and is controlled by the material available and his past experience.

Waterproofing.

Regardless of whether any special means are employed in waterproofing tanks, the careful selection and grading of the aggregate with care in the placing of the same should be followed as given under the head of "Material."

There are various methods of waterproofing concrete in use today, such as mixing a certain percentage of crude oil with the concrete or adding a paste, powder or lixiviating water to the concrete and mixing it with the cement, the mass of the concrete as a whole or with the water. There is no doubt that any of these methods will produce an impervious concrete. However there is always a doubt whether the addition of any extraneous substance to the cement will not in time injure the concrete.

With properly graded material and careful placing of the same it is possible to get a concrete that would not require more than an application of bituminous paint on the inside to prevent any seepage of water.

The cement gun has been used quite successfully in waterproofing reinforced concrete reservoirs in California. It was used in giving a coating to the bottom and sides of the large Twin Peaks reservoir which was built for the city of San Francisco. This reservoir is 370 ft. long, 285 ft. wide and 27 ft. deep, and has a capacity of 11,000,000 gallons. It is divided into two parts by a partition wall in order that one-half of the reservoir may be cleaned and repaired without leaving the city unprotected.

When the reservoir was first built it was found that there was consid-

erable leakage and the engineers decided to trv the cement gun. A mixture of one part Portland cement to three parts of graded sand was used and to this was added a small quantity of hydrated lime. The coating put on by the cement gun varied in thickness from one-quarter of an inch at the top to one-half inch at the bottom. The concrete was kept thoroughly wet before the gunite was applied, and was also kept wet for several days afterwards. As soon as the work of the cement gun was finished the reservoir was filled and while, at the end of 24 hours a slight seepage showed on the wall, this disappeared at the end of 48 hours and the coating is apparently a success.

The cement gun has also been used in California in coating tanks used for the storage of slop distillate. This is a comparatively new process and is well worth trying where the apparatus is available.

Cost.

The first question that naturally occurs to one when a concrete tank is mentioned is, "What will it cost?" We have not collected many data on the subject, but have tabulated what we have received in such a manner as to enable one to make an approximate estimate should he have occasion to build a tank under similar conditions.

The concrete tank costs more than other tanks, but the first cost ought not to be the governing feature. A careful comparison should be made of different designs and styles of construction of tanks having the same capacity and serving the same purpose and the cost per annum in each case arrived at. The cost per annum is the average cost per year for the life of the structure.

The total cost is made up of the original cost of the structure; interest on the original cost for a period equal to the life of the structure; the total maintenance charges during the life of the structure; the interest on the maintenance charges from the time expenditures were made until the end of the life of the structure; and the risk or liability of destruction by storm or fire, whether covered by insurance or not. The total of these items divided by the number of years of life of the structure equals the cost per annum.

The building of concrete tanks is a comparatively new field and sufficient time has not elapsed since the last report to bring forth any new developments.

W. F. Strouse, assistant engineer, reports that the tank built at Sir Johns Run, W. Va., for the Baltimore and Ohio by the Steel Concrete Construction Company, has passed the severe winter of 1911-12 without showing any bad effects and that only a slight sweating or seepage has appeared. This seepage is a common occurrence and begins to show soon after the tank is first filled. This has usually disappeared after a few weeks, and tends to prove the theory, that, whether it is caused by the porousness of the concrete or by cracks developing because the concrete is stressed beyond its elastic limit, precipitates from the water soon fill up the interstices and the tank becomes absolutely water tight.

Another tank has since been built by the B. & O. at Chicago Junction, Ohio, having the same capacity, 100,000 gallons, and the same diameter, 25 ft., but the height of the tank bottom above the base of rail is 50 ft. instead of 30 ft. as at Sir Johns Run. The Chicago Junction tank is really a three story structure, the basement being used as a pump room, the second story for storage and the third for water. This tank was also built by the Steel Concrete Construction Company of Pittsburgh. Both tanks were designed and constructed under the supervision of F. L. Stuart, Chief Engineer.

In the Engineering News of February 1st, 1912, appeared an article on the failure of a steel stand pipe at Sheboygan, Wis., on the evening of January 15, 1912. This stand pipe was erected in 1887 at a cost of $13,000, was 140 ft. high above foundation and was 20 ft. in diameter. The failure was due to ice forming in the stand pipe on account of two weeks of unprece-

Concrete Tank at Sir John's Run, W. Va., Baltimore & Ohio R. R.

dented cold weather. Because of the large amount of water consumed the pumps were run continuously to keep up the supply, and as a consequence there was no circulation in the stand pipe and it acted merely as a balance on the system. An ice cap formed at the top, a thick layer of ice formed at the bottom and the intervening space was partially filled with a circumferential lining about 2 ft. in thickness. The amount of ice which fell with the tower is estimated at 950 tons. Fracture occurred at the bottom, parts of the lower rings being thrown 100 ft. away from the foundation in the direction opposite to which the tower fell. If this had been a reinforced concrete tank this collapse could not have occurred.

Mr. L. J. Mensch, contractor, of Chicago, has recently completed the construction of a 600,000 gallon reinforced concrete tank for the city of Berlin, Ontario. The elevated tank is supported by a reinforced concrete tower or shell, 12 in. thick and 80 ft. high, resting on a circular foundation 13 ft. wide. The tank is 52 ft. in diameter and is designed to carry a depth of water of 45 ft. It is surmounted by a dome-shaped concrete roof. The bottom of the tank is a double dome similar in design to the tank for the Chicago City Railways Co., previously described. The two domes are so designed that the thrusts at their juncture nearly balance when the tank is filled. When the tank is empty the thrust of the outer dome is much greater than that of the inner dome and this is taken care of by an increased section of concrete. The section of concrete is also materially increased at the junction of the outer dome and the shell of the tank.

The reinforcement of this tank consists of high carbon steel square bars of plain sections. The mixture of concrete in all portions of the tank in

Concrete Tank at Sir John's Run, W. Va., Baltimore & Ohio R. R.

direct contact with the water is 1: 1: 2, while in other portions of the structure the mixture was proportioned in the ratio of 1: 2: 4.

The lower shell or tower was built by using wooden forms 6 ft. deep, and the concreting was done at the rate of from four to six feet per day. The forms for the tank proper were in sections 3 ft. 1 in. high and 8 ft. long; the outside forms were kept from spreading by using tank hoops. Two sets of forms were used, one on top of the other, in order that one set of forms would serve as a support for the next while being placed. A dam of sheet steel six inches wide was imbedded three inches in the concrete at the end of each day's work

This tank is of special interest because it is the most recent structure of this kind of which we have been able to obtain a record,—having been begun in August and completed the latter part of November of this year. It is the largest elevated reinforced concrete water tank ever built and is also the largest elevated tank of any kind in actual service. An elevated steel tank is in existence, having a greater capacity but it has never been put into use. The construction of this tank was successful and showed no sign of leakage or seepage after being filled with water

An elevated concrete tank of an unusual design has been built by the Chicago City Railways Company to provide pressure for its shop sprinkler system. It has a capacity of 100,000 gallons, is 30 ft in diameter and 20 ft. high and the tank bottom is 75 ft above the ground level The double dome bottom is entirely different from that of other tanks mentioned in this report

An eight inch wall was used but the engineers say they would reduce this to six inches if another tank were built. The roof is of concrete and spherical in shape, and the tower consists of four posts spread to 42 ft.

Concrete Tank at Sir John's Run, W. Va., Baltimore & Ohio R. R.

10 in. centers at the ground level in order to clear the pump house below. The tank was designed by Hugo Schmidt, superintendent of buildings for the railway company, and built by L. J. Mensch, contractor.

Last year the city of Norway, Mich., built a concrete tank in connection with its gravity water supply system The tank has a capacity of 300,000 gallons, is 43 ft. high with an inside diameter of 35 ft and has walls 12 inches in thickness. The tank rests on a solid rock base and is entirely above the ground. The following is quoted from Engineering and Contracting with the permission of L. R Howson, resident engineer for Alvord & Burdick of Chicago, who contributed the article:

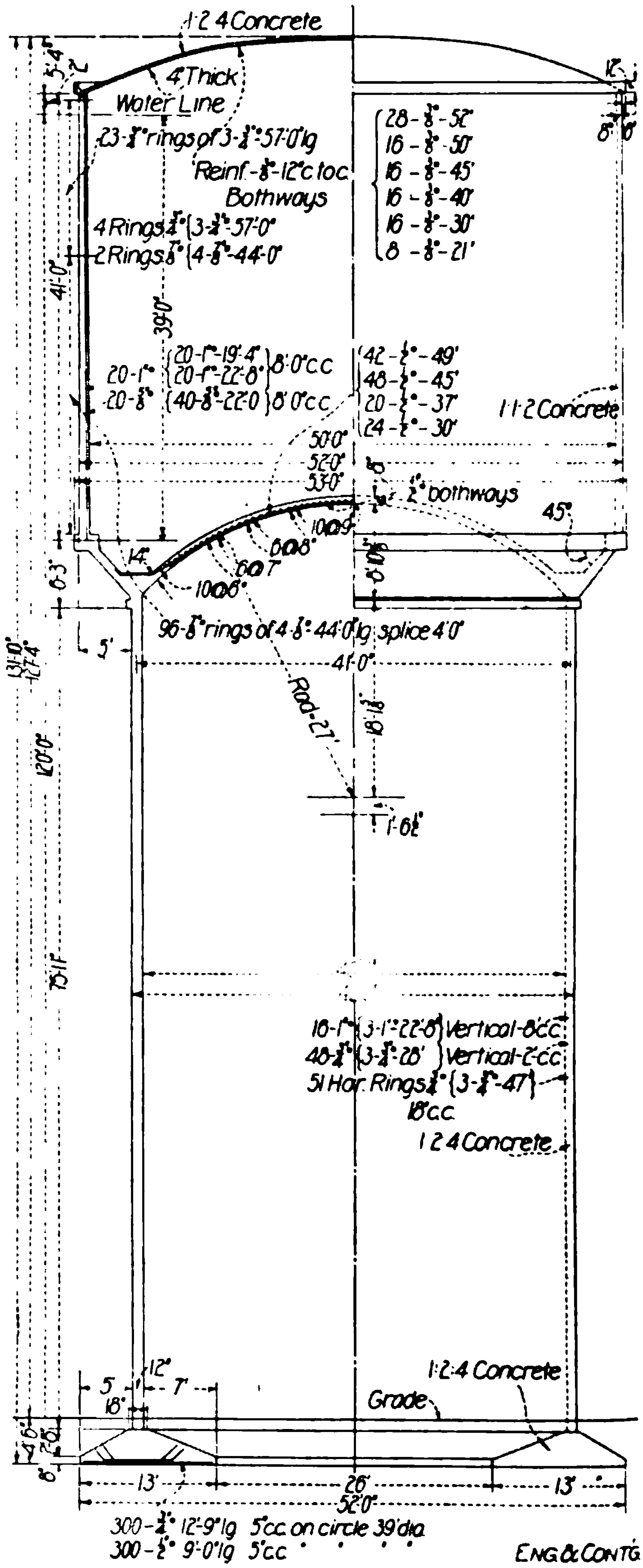
"The forms were built in sections 5 ft. in length by 3 ft. in height, and two complete inside and outside rings were used. The forms were of 1-in. clear lumber, dressed on one side and two edges and nailed into a vertical position. Before the forms were used they were given two coats of heavy black oil to prevent the cracking and swelling of the wood. Each time the forms were shifted they were given a coating of paraffine oil to keep the concrete from adhering to them, care being exercised to allow no oil to drip on the concrete joint surface and destroy the bond The forms were banded together with two rings of ¾ in. rods drawn tight with turnbuckles. The appearance of the finished tank would have been improved by using a light galvanized lining for the outside forms. Before the walls were started, a complete inside framework to carry the dome and bracing was constructed, and a tower to carry the hoisting cages.

"The steel was of the plain circular bar type, having an elastic limit of 50,000 lbs. per sq in. It was originally intended to use "deformed" bars, but the great difficulty experienced in bending these bars in a plane caused the adoption of the plain section. The bars were 1-in. and ⅞-in. in diameter and were placed in two circles for the bottom 18 ft. of wall, the upper part having but one ring. One-half inch circular rods were placed vertically at 15 ft. intervals to serve as tie rods. The bottom was reinforced in two directions to care for temperature stresses. The dome was reinforced with woven wire Special care was used to keep the bars a sufficient distance apart to insure a perfect bond on all sides of the bar. The joints of the bars were made without the use of clips, the bars being lapped 50

Reinforced Concrete Tank, Berlin, Ontario, Capacity 600,000 Gallons.

diameters and held apart at least one diameter. All joints were staggered one-eighth the circumference and two bars made one ring around the tank. Care was used throughout the work to prevent the shifting of forms or of steel after the concrete had begun to set. The steel was all bent to shape on the ground with templates and an eye bar at a cost of 50 cents per cu. yd. of concrete. Bending and placing the steel cost $5 per ton. The chief details of the design are shown in the accompanying drawing.

The concrete was a 1: 1: 2 mixture; earlier difficulties with a 1: 2: 4 having demonstrated that the additional expense of a 1: 1: 2 mixture in waterproof work is well justified. The brand of cement was the "Huron" and tests of samples sent to Robt W. Hunt & Co. showed a neat strength of 398 lbs. per sq. in. in 24 hours, and 760 lbs. per sq. in. in 7 days; a 1: 3



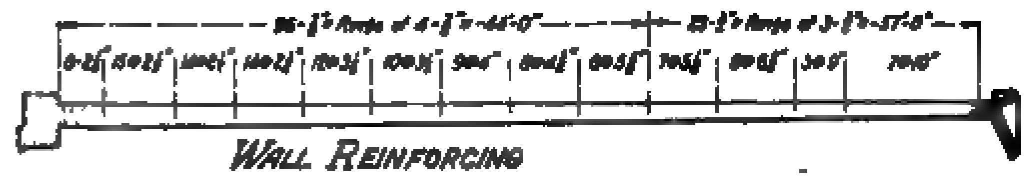
Reinforced Concrete Tank, Berlin, Ontario, Capacity 600,000 Gallons.

mixture tested 123 lbs. per sq. in. in 24 hours and 373 lbs. in 7 days.

"The stone was specified as between 1/8 in. and 3/4 in. in size, and was at first obtained from local gravel pits, but due to the very small percentage of material screened out of the required size, crushed stone was shipped from a point nearly 300 miles distant, and this item of stone cost materially raised

LOCATION	NO.	SIZE	LENGTH	REMARKS
ROOF	28	[illegible]	52'	
	16	"	50'	
	"	"	46'	
	"	"	40'	
	"	"	30'	
	8	"	21'	
	12 8	[illegible] [illegible]	57' 44'	
SHELL	69	[illegible]	57' 0"	
	384	[illegible]	44-0"	
	20	1"●	19'-4"	
	20	"	22'-8"	
	40	[illegible]	22'-0"	
RING AT BASE OF SHELL	86	[illegible]	44'-0"	AND 8-[illegible] - 36'-6"
	20	[illegible]	16"	
	"	"	20"	
	"	"	29"	
INVERTED DOME	33	[illegible]	44' 0"	LOWEST RINGS 2-44' 2-36'6
	27	"	36' 6"	NEXT 3 RINGS 3-44' 1 36'-6"
	210	[illegible]	10' 6"	BENT
	"	"	5'-6"	
	420	[illegible]	2'-0"	BENT
INNER DOME	42	[illegible]	49	
	46	"	45'	
	20	"	37'	
	24	"	30'	
SUPPORTING SHELL	24	[illegible]	36'-9"	
	200	[illegible]	16"	
	46	1"●	22'-6"	
	144	[illegible]	25'-0"	
	153	"	47'-0"	
FOOTING	300	"	12'-9"	
	300	[illegible]	9'-0"	BENT

DETAIL OF INVERTED DOME



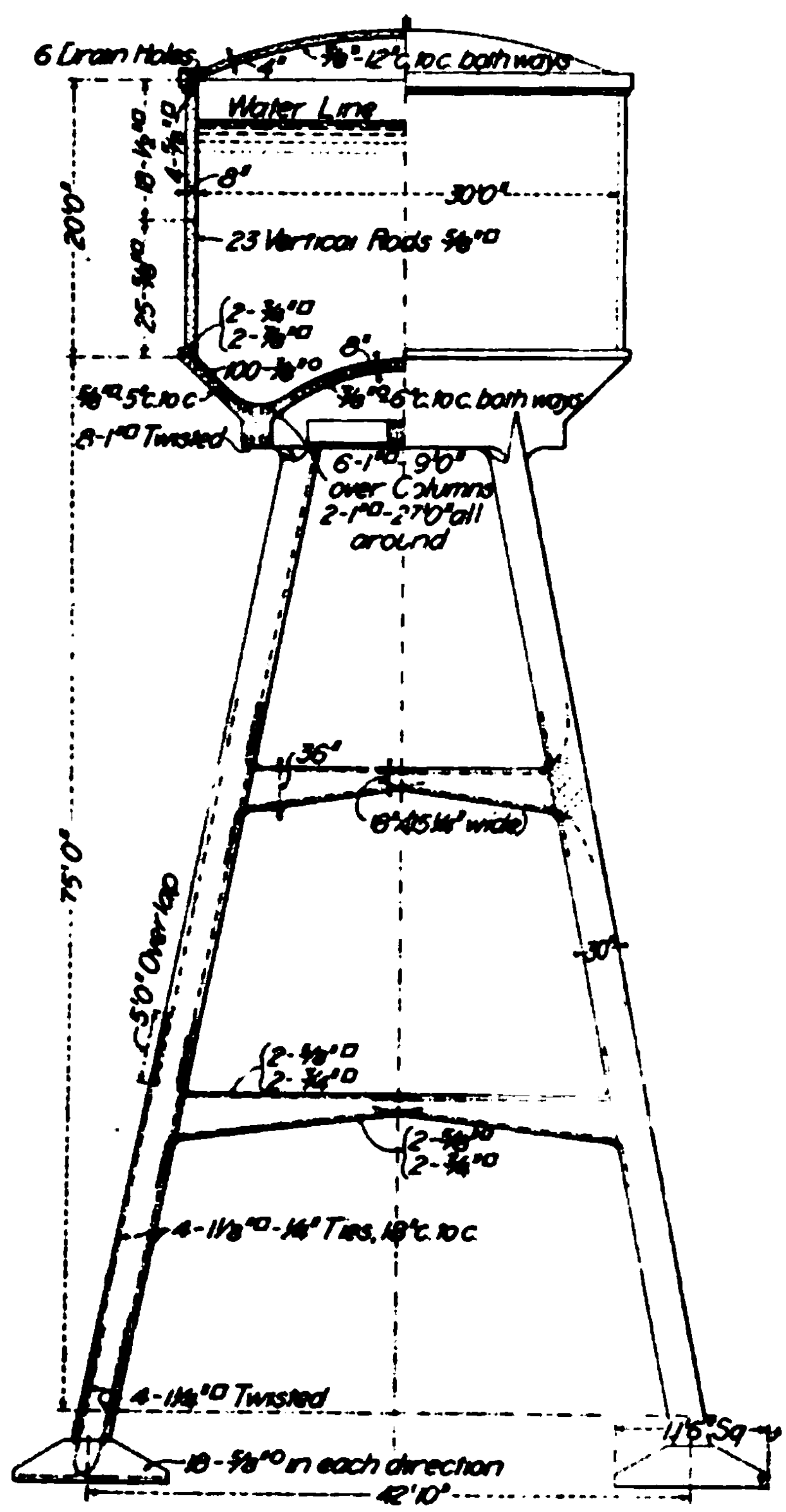
WALL REINFORCING

Reinforcement for Concrete Tank at Berlin, Ontario.

Elevated Concrete Tank with Double Dome Bottom, Chicago City Railways Co., Chicago, Ill.

the concrete coat. Excellent sharp clean sand was found at a pit near the standpipe site.

The cement was mixed with 10 per cent by volume of hydrated lime for waterproofing. All mixing was done by hand labor and great care was used to see that the mixture left the board as uniform as possible. The concrete was all a wet mixture, but not so sloppy that the stone would settle to the bottom when the concrete was spaded. Three feet of concrete wall was placed per day, the rest of the time being used in raising the lower set of forms and placing the steel ready for the next day's work. Working in this way, the difficulty of securing watertight joints is much greater than where only brief rest periods are allowed between pourings. Before placing concrete, the top of the previous day's work was roughened and cleaned.

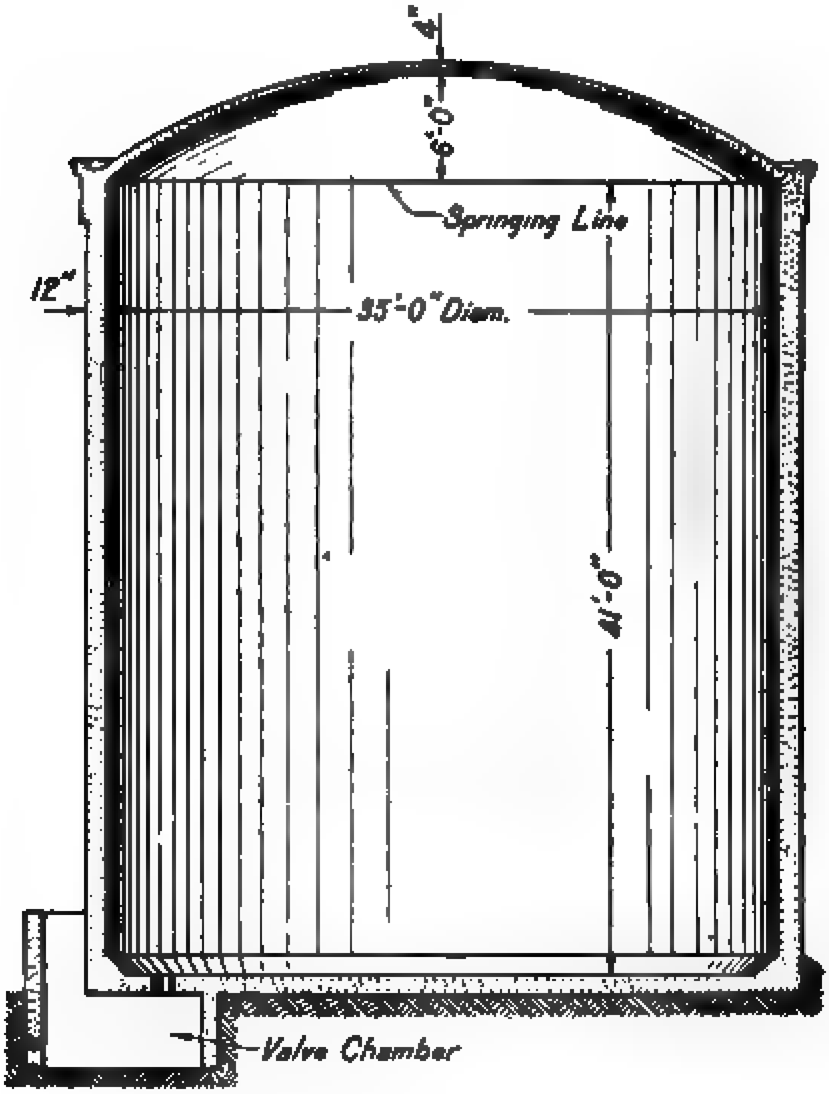


Concrete Tank for Chicago City Railways Co.

then covered with a ½ in. layer of 1 : 1 mortar in which the cement contained 10 per cent hydrated lime upon which the concrete was placed. Both form faces were spaded carefully with mortar hoes which had been straightened, and upon the removal of the forms no stones were visible at the surfaces of the walls.

"The roof is a reinforced concrete dome 4 in. thick at the crown and 6 in. thick at the springing line, and reinforced with American Wire Company's woven wire. The forms were supported upon a series of trusses which rested upon the inside scaffolding for the walls. The face boards of 1-in. lumber were well soaked and drawn to the spherical surface of the dome. The concrete for the dome was a 1 : 2 : 4 mixture and was mixed quite dry, so that it could be placed upon the spherical surface without sliding. A low parapet was constructed and the roof drained to one point at which was located the overflow of the tank which also carried roof drainage.

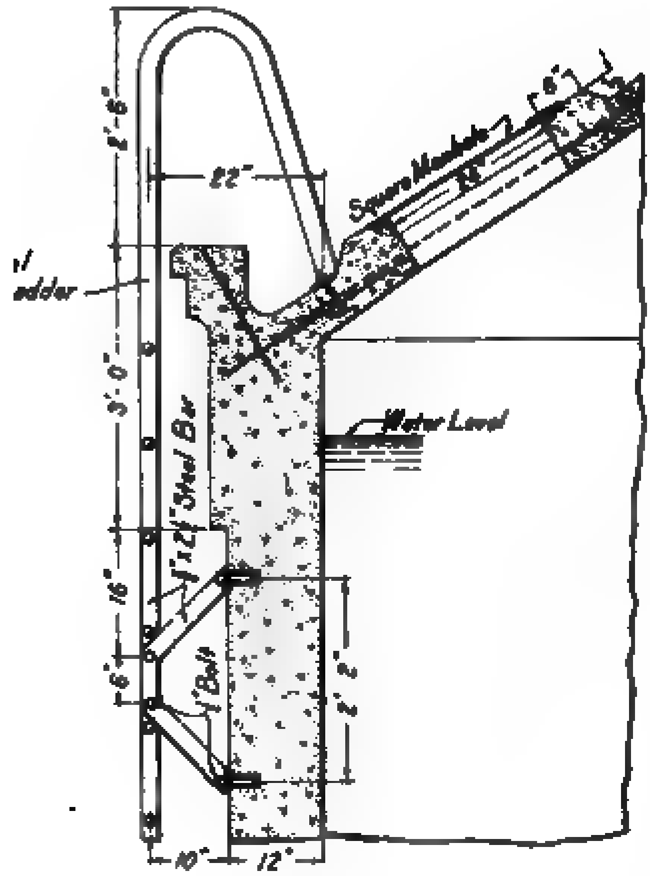
"After the entire tank was completed it was given three coats of plaster inside, mixed in the proportions of 1 part cement, 1½ parts sand, ¼ part hydrated lime and hydratite. The first coat of ¼ in. thickness was applied rough, and while still wet was covered with a second coat about ⅛ in. thick which was brought to a wood floated surface; this was next gone over with a brush coat and brought to a very smooth troweled finish. The plaster was applied in circumferential strips 6 ft. in height, and the cost of the three coats per sq. ft. of surface was 7¼ cts.



Vertical Section

Bottom Reinforcement.

Reinforced Concrete Tank for Gravity Water Supply, Norway, Mich.



Bottom & Wall Connections

Ladder & Manhole Details.

Details for Concrete Tank, Norway, Mich.

"Upon the completion of the entire tank, it was filled and allowed to stand 48 hrs and no change in the water level could be detected. For the first week, however, some sweating was noticeable, but in only one place was it of enough consequence to gather and flow, and this evaporated before it was 3 ft below where it first appeared. No attempt was made to remedy the sweating other than emptying the tank and refilling in two days, but within ten days all discoloration disappeared and no sweating has since been apparent. The tank received a severe winter's test during the past winter when ice over 2 ft. in thickness covered the top and extended around the side walls of the tank well.

"The more successful waterproof construction effected in this tank using a 1: 1: 2 mixture than in others built under the same supervision and care but of 1: 2: 4 mixture, seems to justify the additional expense for cement. The plaster is also an effective 'waterproofing aid' although how large a part of the good results obtained here, are due to the plaster and the 1: 1: 2 mixture respectively is a matter of personal opinion. Results secured by plastering other large tanks of 1. 2: 4 mixture would seem to indicate that the mixture was more important than the plaster face."

The total weight of the reinforcing material in the tank is 45,400 lbs. The outside surface of the tank was not given any treatment except that rough places where the forms were joined were chiseled off to give a smooth appearance. The tank is quite a distance from the town and the nearest street is about 300 ft. away. From that distance the tank presents a smooth appearance. The plans were made by Alvord & Burdick, hydraulic and sanitary engineers of Chicago, and L. J. Mensch was the contractor.

In connection with the water power developments at Ephratah, New York, built by the Mohawk Hydroelectric Company, a surge tank of concrete was constructed. The following quoted from the Engineering Record of November 15, 1911, is of interest in explaining the mixing of concrete and the water proofing: "SURGE TANK:—The surge tank is a cylindrical

concrete structure 25 ft. in diameter and about 50 ft. high. The concrete was mixed with an excellent grade of sand and with crushed stone that passed through a 1-in. screen, averaging about ½ in. in size. The voids in this stone were determined and sand proportioned slightly in excess. The voids in the sand were determined and cement slightly in excess added. The resulting mixture was approximately 1 part cement, 1.8 parts sand and 2.5 parts broken stone. The forms were removed the day following the placing of the concrete, and the interior painted, while still green, with two coats of neat cement wash. Although the tank was constructed in cold weather, requiring protection by canvas and the use of steam coils on the fresh concrete it is said that an absolutely tight job was obtained."

In the Railway & Engineering Review of Dec. 5th, 1911, is a description of a fuel oil installation on the Great Northern Ry. and the drawings show concrete sumps built in connection therewith. These sumps are 22 ft. inside diameter, 7 ft. high and have a capacity of approximately 18,000 gallons. The article does not explain the construction of these sumps, but the drawings shown indicate clearly the manner of placing the reinforcement, and for that reason they are of interest.

The town of Waverly, Ohio, built a concrete water tower with a capacity of 120,000 gallons, beginning the work late in the fall of 1910. When about half finished the extreme cold weather obliged them to stop work and it was completed in February, 1911. The tests made in May 1911, were very satisfactory and showed no ill effect on account of the interruption.

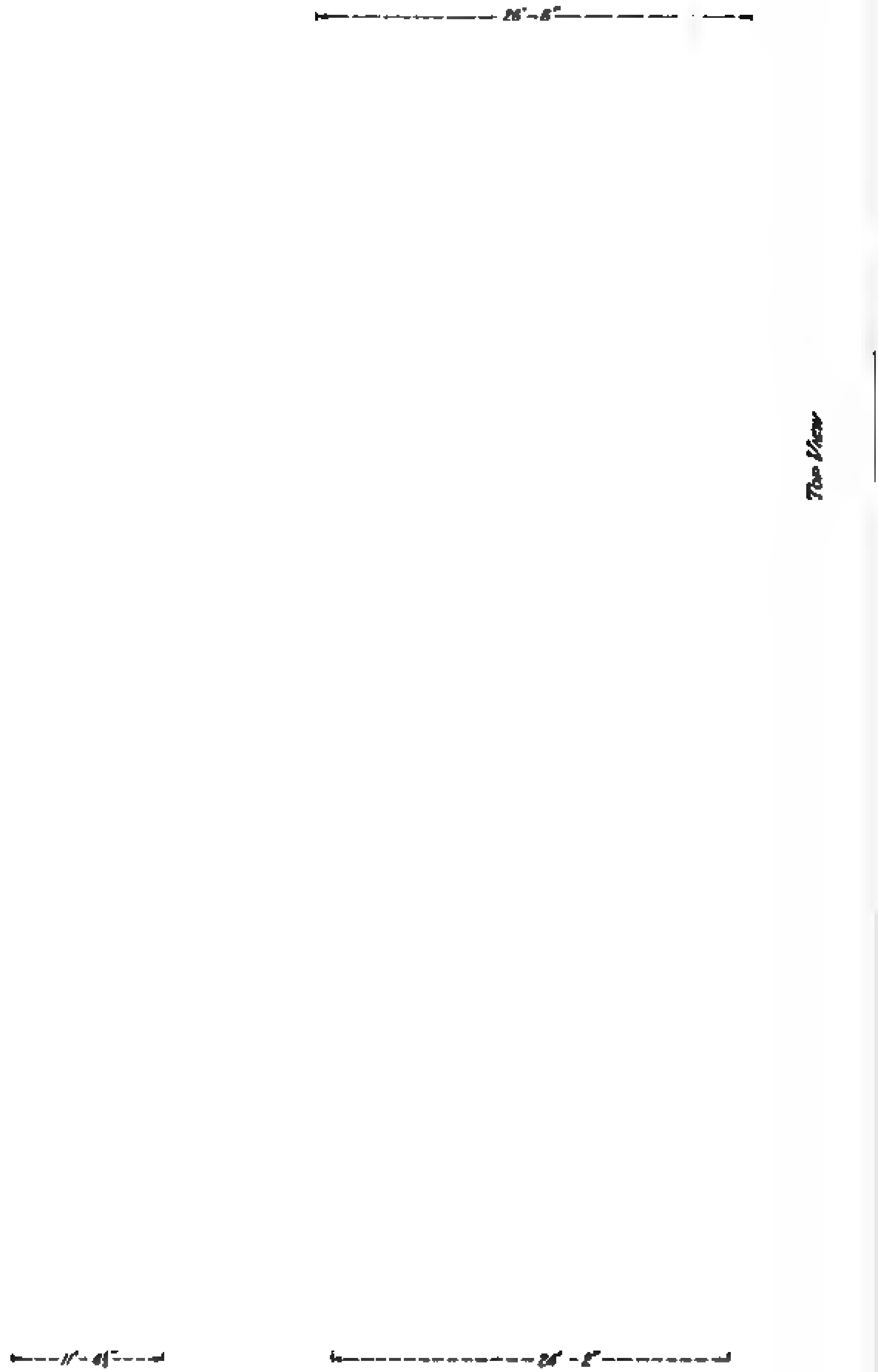
This tower rests on an octagonal foundation 22 ft. in diameter and 7 ft. deep, which also forms the floor of the tank. Horizontal reinforcement was placed when within 18 inches of the top of the foundation consisting of ⅝ in. rods bent at right angles, the horizontal part being about 4 ft. long, spaced 18 inches and about 4 inches from the outer side of wall. A ⅝ in. rod was placed in the angle and the perpendiculars were wired to it.

Drawings are submitted showing details of construction of two reinforced concrete reservoirs built by the Chicago, Milwaukee & St. Paul. The one built at Milwaukee Shops, Wis., in 1906 is rectangular in shape, 22 ft. 8 inches wide, 73 ft. 4 inches long and 9 ft. deep with a capacity of 100,000 gallons. It is placed below the surface of the ground and has proven very satisfactory. The second is a circular concrete reservoir 40 ft. in diameter and 12 ft. deep with a capacity of 100,000 gallons, now under construction at Godfrey, Ill. Another tank was built at Corliss, Wis., in 1910, which is 35 ft. in diameter and 9 ft. deep, with a capacity of 60,000 gallons.

The Baltimore & Ohio has recently completed two concrete water tanks 55 ft. in diameter and 12 ft. in depth at the new water station, which will be known as Miller, W. Va., located at the west end of the Cherry Run Yard. These tanks have a capacity of about 200,000 gallons each and were constructed in accordance with the details shown on the accompanying plan. The location is along a steep hillside on a shelf or bench formed by cutting away the earth and rock at an elevation of about 50 ft. above the track level, where the penstocks are located.

The site was levelled down to the established elevation by cutting away the earth and rock where it was above grade and by building up concrete ribs to support the bottoms where it was below. About one half of the total area occupied by the two tanks is solid rock, and the balance compact clay with the concrete ribs above mentioned which were carried down to a satisfactory bearing material.

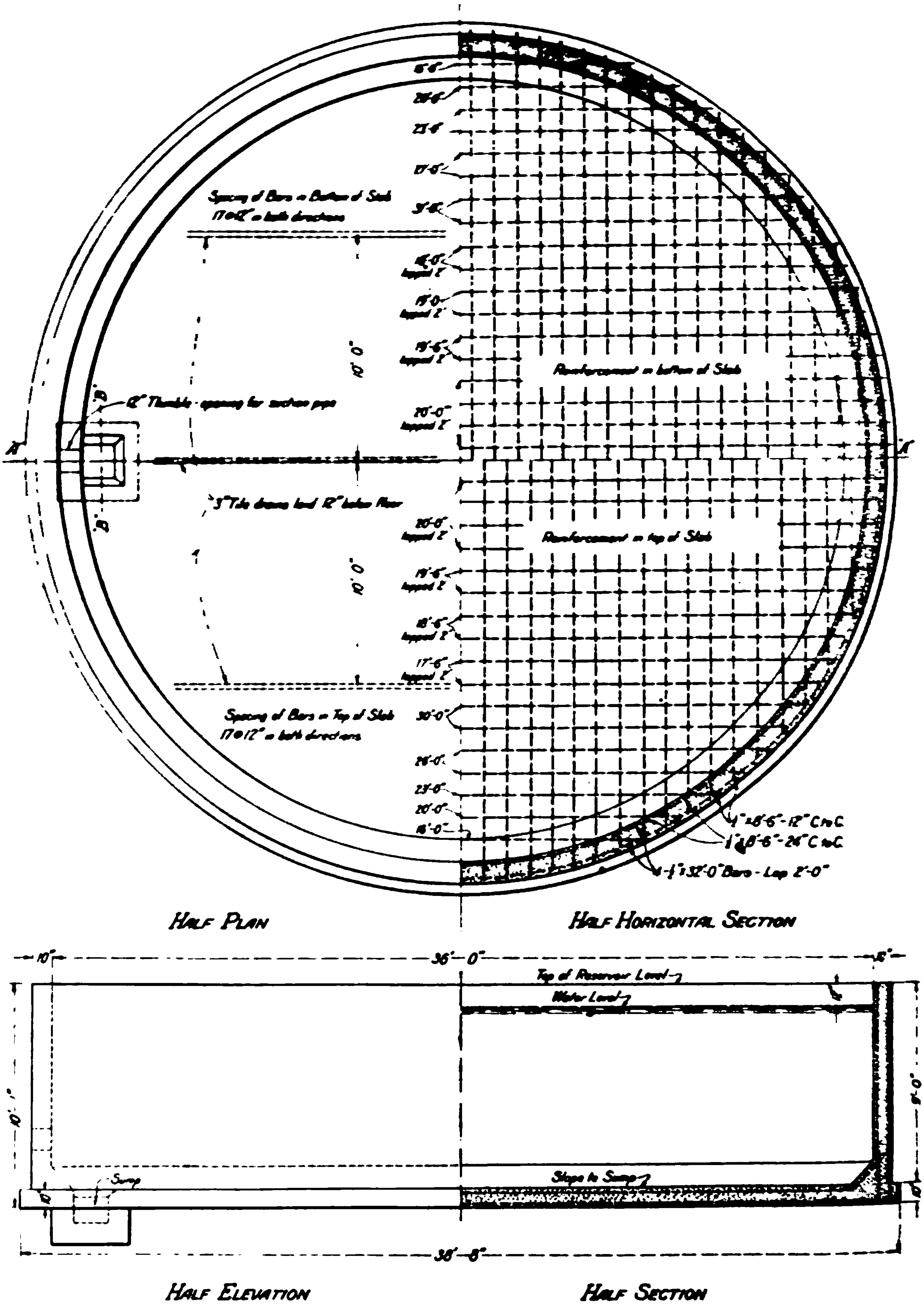
When the site was ready, forms were constructed for placing the bottoms of both tanks. The concrete for each bottom was placed at one pouring. Short sections of reinforcing rods were bent and set up in the concrete in the location of all columns and in the grooves around the outer edge of the bottom to which to splice the reinforcing material for columns and outer walls. As soon as the concrete had properly set, forms and reinforcing rods were set up for the wall of one tank, the concrete for which was all placed at one operation without interruption. The columns, beams and roof were not poured until the walls were sufficiently set to allow the



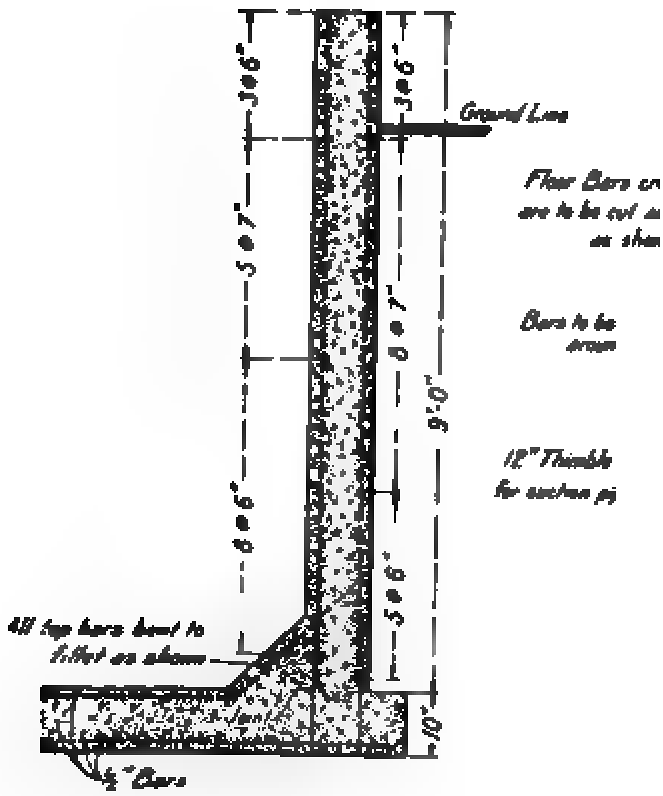
Concrete Reservoir, 100,000 Gallons Capacity, C. M. & St. P. Ry., at Milwaukee, Wis.

PLAN

Details Concrete Reservoir at Milwaukee, C. M. & St. P. Ry.

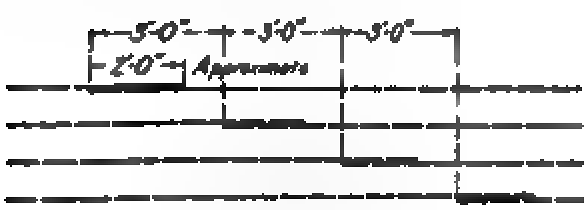


Concrete Reservoir at Corliss, Wis., C. M. & St. P. Ry., Capacity, 60,000 Gals.



SECTION OF WALL

SECTION "A-A" OF SUMP

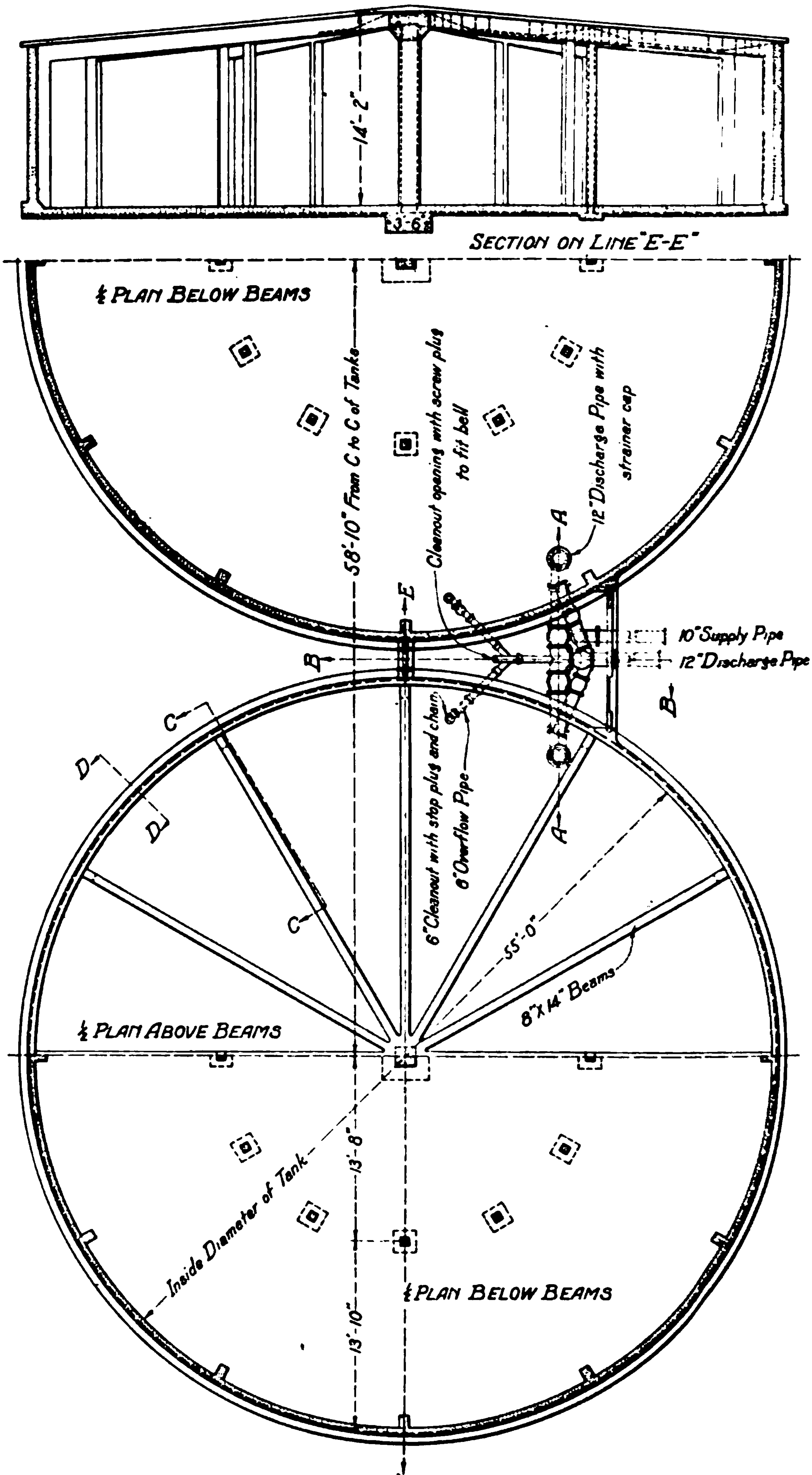


LAP OF BARS IN WALL

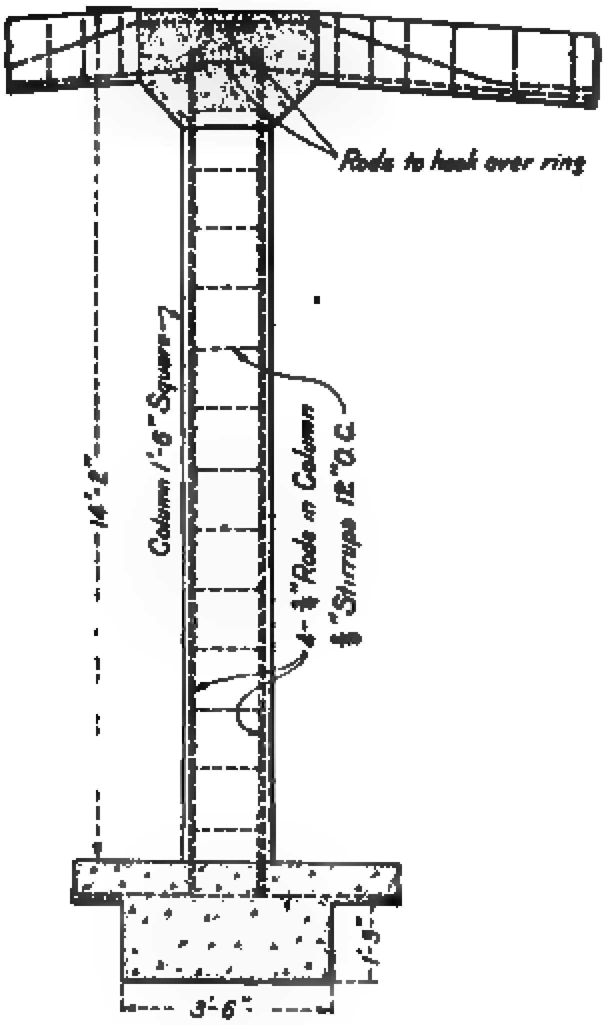
DETAIL OF WALL AT SUCTION PIPE

BILL OF BARS				
	NO	SIZE	LENGTH	REMARKS
FLOOR	6	1"	6'-6"	Sump Bar "A"
	6	"	9'-0"	" " "B"
	4	"	16'-0"	Transverse in bottom
	4	"	20'-0"	" " "
	8	"	23'-0"	" " "
	8	"	27'-0"	" " "
	8	"	31'-0"	" " "
	16	"	18'-0"	" " "
	16	"	19'-0"	" " "
	16	"	19'-6"	" " "
	32	"	20'-0"	" " "
	4	"	16' 0"	" " Top
	4	"	20' 0"	" " "
	4	"	23'-0"	" " "
	8	"	26' 0"	" " "
	8	"	30'-0"	" " "
	16	"	17' 6"	" " "
	16	"	18'-6"	" " "
	16	"	19' 6"	" " "
	32	"	20' 0"	" " "
	176	"	2'-0"	Dowels
WALL	68	"	32'-0"	Inside Wall
	68	"	32' 0"	Outside Wall
	176	"	8' 6"	Vertical

Details, Concrete Reservoir, Corliss, Wis., C. M. & St. P Ry.

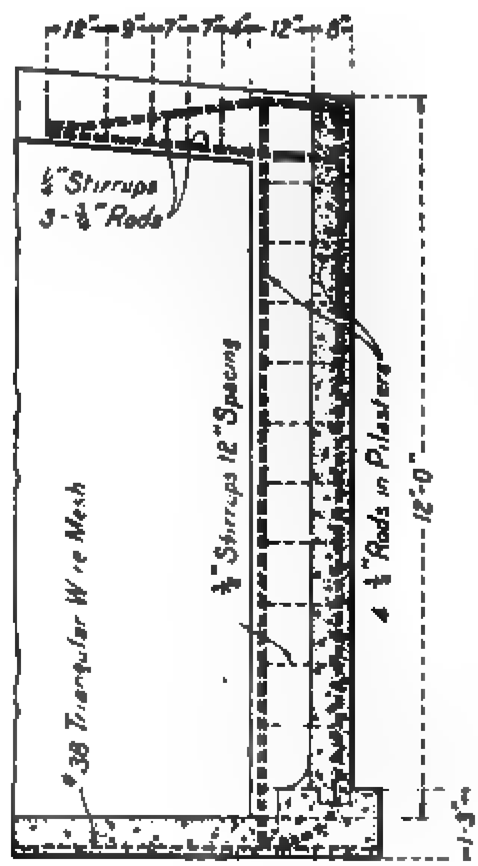


Twin Concrete Reservoirs, Miller, W. Va., B. & O. R. R.



ELEVATION OF CENTER COLUMN

SECTION "D-D"



½" Rods 24

PLAN THROUGH WALL AT PILASTER

ELEVATION OF COLUMN & PILASTER ON LINE "C-C"

Details, Twin Concrete Reservoirs at Miller, W. Va., B. & O. R. R.

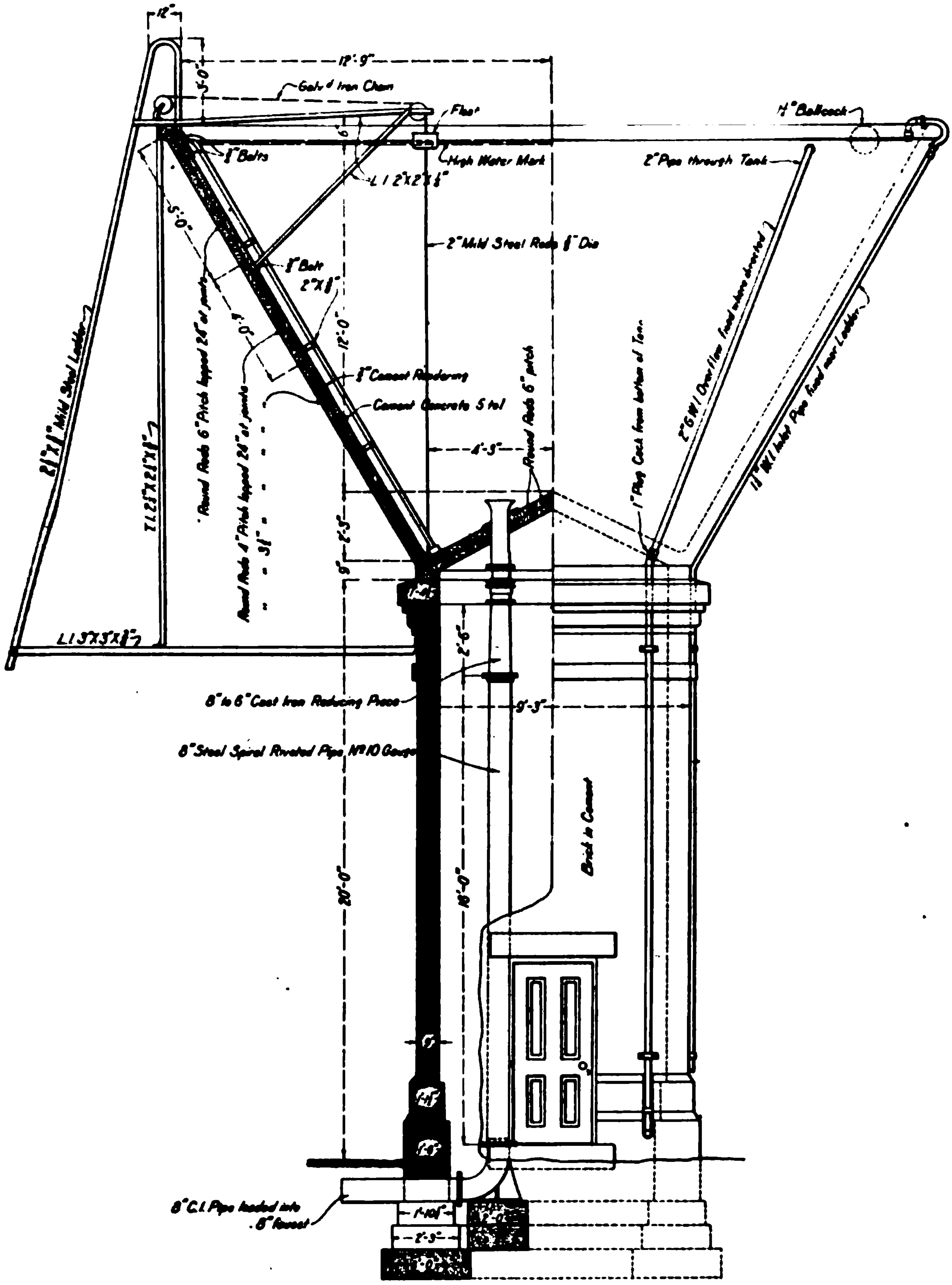
SECTION "B-B"

SECTION "A-A"

Details Twin Concrete Reservoirs, Millar, W. Va., B. & O. R. R.

These two cuts show Construction Work on Concrete Tank for Victorian Railways.

Reinforced Concrete Tank, Victorian Rys., New South Wales, Australia.
Capacity, 25,000 Gallons.



Reinforced Concrete Tank, Victorian Rys., New South Wales, Australia.

removal of the forms, immediately after which they were rubbed down to proper surface. The construction of the second tank was similar to that of the first, the forms and other material being used a second time. All concrete was of 1: 2: 4 mixture. Hydrated lime in the proportion of 8 per cent of the volume of Portland cement was used for waterproofing purposes. As far as possible the wall forms were held in position by braces from the outside, the only connection between the outer and inner circle being sufficient wires to hold the spacing strips in position. These wires were cut a short distance beneath the surface of the concrete and the place carefully cemented up before the concrete had dried out, the object being to prevent all metal from showing on the surface.

The arrangement of the reinforcing material is shown on the plan. Where splices in the column occurred the lap was 30 diameters and the rods were secured with No. 12 annealed wire. The horizontal circular rods of the walls were lapped 30 diameters and clamped with Crosby wire rope clips. The vertical rods in the walls were wired to the horizontal rods with No. 12 annealed wire. The bottom was reinforced with No. 38 triangle mesh made by the American Steel & Wire Company.

After the tanks were completed the inside of the walls was given an application of "por-seal." After this had thoroughly dried these surfaces were given a coat of Carey's asphaltic damp-proof paint. These tanks have been filled with water for the past thirty days and while there was some seepage when they were first filled, all pores have now apparently closed up. and at the present time the outer surfaces of the walls are almost perfectly dry.

A distinct departure from the general design is a tank built quite recently by the Victorian Railways in Australia. It is a hollow, inverted frustrated cone of reinforced concrete resting on a hollow cylinder or tower of brick. This funnel shaped structure has an inside diameter at the top of 25 ft. 6 in. and the water reservoir is 12 ft. deep from the highest part of the floor to the high water mark. The diameter of the water reservoir at the bottom is 8 ft. 6 in. The brick tower has an outside diameter of 9 ft. 3 in. and is 20 ft. high. The total height of the structure above foundation is 35 ft. 6 in.

This funnel shaped tank has a capacity of 20,000 gallons, and while it is an odd looking structure it has the advantage of giving the maximum of water at the maximum head and materially reducing the total weight of the structure. This design is of interest particularly because it shows that it is not necessary to confine ourselves to the old established and well beaten paths. Some photographs and a drawing are reproduced as a part of this report, and the following specifications are interesting.

F. E. Weise,
W. H. Finley,
W. M. Clark,
D. G. Musser,
Committee.

Location	Date	Purpose	Water Reservoir						
			Cap. in Gallons	Dia	Depth	Wall Thickness		Floor Thickn's	Roof
						Bottom	Top		
Somerset Pa.	1911	Town water-supply water obtained from 3 drilled wells.	500,000	Top 81'-4" Bot 80'-0"	15'-10"	18"	10"	6"	Reinforced concrete 5" thick carried on 10" I-beams supported on 4" W.I. pipe posts
Westerly R.I.	1910	Town water-supply water obtained from driven wells.	660,000	40'-0"	70'-0"	4'-0" at floor tapering to 14" at height of 5'-0"	14"	12"	Gustavino dome of red tile
Norway Mich.	1910	Gravity water-supply for city purpose	300,000.	35'-0"	43'-0"	12"	12"	12"	Concrete dome reinforced with woven wire
Waverly Ohio.	1911	City water-supply	120,000	20'-0"	80'-0"	9"	6"	Foundation forms floor	4" Concrete
Kilbourn Wis.	1911	City water-supply	63,000	30'-0"	9'-0"				Timber and Paroid
Austinburg Ohio	1910	Locomotive supply for Pennsylvania Lines	54,000	24'-0"	16'-0"	8"	6"	8"	Wood
Anaheim Cal	1907	City water-supply	172,000	30'-0"	32'-0"	10"	6"	10"	Concrete
Key West Fla.	1911	Supply for U S Naval Station	1,500,000	80'-0"	40'-0"				None
Sir John's Run W Va	1911	Locomotive supply for B & O Ry.	100,000	24'-0"	30'-6"	10"	7"		

Construction Data, Various Tanks and Reservoirs.

Tower or Tank Support	Foundation	Reinforcement	Concrete	
			Proportions and Aggregate	Mixing and Placing
On Ground	Excavation in clay to sandstone formation about 5 ft below surface	Walls square twisted steel rods with horiz and vert wired at intersections. Roof - $\frac{7}{8}$" square twisted rods laid across I-beam stringers, spaced 4" centers, and triangular wire mesh	1:2:4 Lehigh Port. Cement Crushed Rock Sand Sand Rock Ballast	Mixed very wet in continuous mixer. Spaded and worked uniformly in forms.
On Ground	Rests on hard pan 5 or 6 ft below surface of ground		Walls 1:1½:3 Vulcanite Port. Cem. Sand containing some Gravel Crushed Granite Cornice 1:2:4 Foundation 1:3:6	
On Ground	Rests on solid rock foundation entirely above ground	45,450 lbs plain round bars Walls - Lower 18 ft of 2 circles of 1" and $\frac{7}{8}$" rods, above that one circle ½" round rods placed vert at 15 ft intervals for tie rods Bottom reinforced in two directions Radial bent rods lead from bottom to walls 12" centers	1:1:2 Huron Port Cement Clean, sharp sand obtained near by. Crushed stone $\frac{3}{8}$" to $\frac{7}{8}$" in size. Roof 1:2:4	Wet mixture, yet stiff enough so that stone would not settle. Mixing done carefully by hand to insure uniformity
On Ground	22 ft in diam 7 ft deep octagon 1 3 4 mixture of concrete wet but not slushey Top of foundation forms floor of tank and finished 1·2·2	$\frac{7}{8}$" Perpendicular rods spc'd 4 ft $\frac{7}{8}$" Hor rods spaced 8 rings at the bottom and 3 rings at the top to the foot 35,000 lbs steel used	1:2:2	Mixture very wet and slushy
On Ground				
Walls same diam as tank	Pile and Concrete		Rich	
Reinforced Con Tower	Concrete 1·3 4½		1 2·2½	Thoroughly mixed and just wet enough to show water on the surface after a thorough tamping
On Ground	Concrete 1 3 6	Vertical Channels horizontal round rods	1:2·4	
Cyl walls same diam as tank	Concrete 1·3·5	Corrugated steel bars	1:2·4 Portland cement Crushed washed glass. Crushed Limestone	

Construction Data, Various Tanks and Reservoirs.

Forms	Finishing and Waterproofing	Cost		Remarks
		Total	Per 1000 Gals	
Wooden	Walls finished with 2 coats of thick Portland Cement wash. Bottom and roof given sidewalk finish.	$5,500.00	$11.00	Excavated material was placed uniformly about completed sidewalls to a grade line 4 ft. below top of walls. Reservoir is reported water-tight
Wood forms for base. Steel forms for all plain wall.	5% Limoid a patented form of hydrated lime. Floor given 1" granolithic finish and inside bevel a plaster coat of the same.	$17,960.00	$27.22	In appearance and water-tightness one of the most successful ever built.
Wood forms used in 3' sections coated with heavy black oil. A coat of paraffine oil was applied each time forms were shifted.	Cement mixed with 10% hydrated by volume. Rich mixture used. After completion, inside was given 3 coats of plaster 1 part cement 1½ part sand ¼ part hydrated lime and hydratite	$4,745.00	$15.82	Galvanized iron lining of forms would have given tank a better appearance. Results show that extra expense of cement was fully warranted. Sweating noticed when filled but disappeared after 10 days. Passed a severe winter without any bad effects.
Metal forms in 3 sections.		$4,500.00	$37.50	
		$733.20	$11.64	
Steel Forms		$3,500.00	$64.81	Engineer states that from experience gained he recommends a tank with twice the capacity and with a concrete roof.
		$11,400.00	$66.27	
		$19,950.00	$13.30	
Steel Forms	5% hydrated lime	$7,500.00	$75.00	

Construction Data, Various Tanks and Reservoirs.

APPENDIX.

SPECIFICATIONS FOR REINFORCED TANK AT DANDENONG, VICTORIAN RAILWAYS, NEW SOUTH WALES, AUSTRALIA.

NATURE OF WORKS.—The works comprise the construction and erection of a 20,000 gallon reinforced concrete tank on a brick tower, and the supplying, laying and fixing of cast iron, wrought iron and steel inlet and outlet pipes, ladders, ballcock, etc., at the Dandenong railway station, in strict accordance with the drawings and the annexed conditions of contract and schedule and this specification, and to the satisfaction in every respect of the proper chief officer; also the maintenance of the same as provided for in clause No. 34 of the said conditions of contract.

CARRIAGE OF MATERIALS.—The cast and wrought iron, iron pipes and ironwork for use in connection with this contract will be carried free on the Victorian Railways provided that they be consigned on a departmental consignment note, which on the contractor's application will be furnished to him by the superintending officer, and the contractor will be liable to pay full freight on all such cast and wrought iron, iron pipes and ironwork if not consigned as aforesaid. The contractor shall pay full freight on all materials carried by rail excepting the cast and wrought iron, iron pipes and ironwork as aforesaid.

DRAWINGS.—The drawings referred to in this contract are: No. 1—20,000 gallon reinforced concrete tank, litho. No. 377-09 (amended), and such other drawings as the proper chief officer may from time to time make and supply to the contractor.

INTERFERENCE AND PRECAUTIONS.—The works are to be carried out by the contractor in such a manner as not to interfere with or damage or be the cause of damage to any property or rolling stock or any other thing whatsoever belonging to the corporation, and in such a manner as not to interfere in any way with the traffic or business of the corporation or with any other work or contract that may be in progress on any railway line or premises, and no line of railway or any other portion of the railway premises shall on any account or for any reason or cause whatsoever be obstructed by the contractor without the written permission of the proper chief officer or the superintending officer previously obtained, and the contractor shall provide, maintain, and take all precautions which may be requisite for the convenience and safety of the public and the protection of life and property, or which may be required or ordered by the proper chief officer or the superintending officer.

In the event of the contractor's failure or neglect to carry out the works and provide, maintain, and take all precautions in strict conformity with and with due observance of the provisions herein contained, then in every such case, as often as the same shall occur, the contractor will be held responsible and liable for any loss or damage whatsoever, which in the judgment of the proper chief officer shall have been sustained by the corporation owing to any such failure or neglect by or on the part of the contractor, and the amount of any such loss or damages as assessed by the proper chief officer may from time to time be deducted by the corporation from any money due or which may become due to the contractor

EXCAVATION FOR FOUNDATIONS.

All excavation required in any position or form, whether in earth or rock, shall be taken out to the depths, forms, and dimensions shown, or as the proper chief officer or the superintending officer may direct, and no work

shall be proceeded with on any foundations, etc., until such excavation shall have been approved by some one of such officers. All slopes of cuttings and embankments are to be neatly trimmed to the inclinations shown on the drawing or such other inclinations as the proper chief officer or the superintending officer may direct.

The earth is to be deposited in six-inch layers and well rammed round all foundations, pipes, etc., and where ordered.

SURPLUS EARTH.—All surplus earth is to be deposited where and trimmed as directed by the proper chief officer or the superintending officer, the lead not to exceed 20 chains.

SIDE CUTTINGS.—Should any earth be required for embankments, approaches or footpaths, or for completing any portion of the work, the same shall be taken from side cuttings, which are to be excavated by the contractor in such situations and of whatever forms and extent the proper chief officer or the superintending officer may direct, the lead not to exceed 20 chains.

Where necessary the water shall be properly and effectually pumped out of the cuttings, trenches, etc., and the sides of the same properly shored and planked up. All slips that may occur are to be removed by the contractor at his sole expense, and the foundations must be kept dry until the concrete, etc., is properly set and consolidated.

The rate per cubic yard for excavation for foundations, etc., is to include the cost of depositing the surplus earth where directed, all ramming, trimming, etc., and every appliance necessary for the completion of the work, also all additional expense incurred in repairing slips and damage by floods or any other cause.

ONLY THE NET QUANTITY PAID FOR.—Only the net quantity of excavation actually necessary in the judgment of the proper chief officer or the superintending officer for the purpose of receiving foundations, etc., will be paid for, and any excavation in excess of that which is required for such purpose (which the contractor may for his own convenience or safety take out) will not be paid for, but the space caused by such excess excavation shall be filled with approved material rammed in to the satisfaction of the proper chief officer or the superintending officer by the contractor at his own expense.

CEMENT.—All cement must comply with the " Standard Specifications for Portland Cement for the State of Victoria."

BRICKWORK.—The bricks are to be machine pressed, specially moulded to suit radius of tower, of approved make, sound, hard and well burnt. The beds and joints are to be full of mortar and the joints are to be neatly struck; no grouting will be allowed; the height of every five courses shall be 16¼ in. All bricks are to be thoroughly wetted before being laid, and shall be laid in approved bond. Spaces are to be left for the inlet and overflow pipes as shown.

BLUESTONE.—The bluestone is to be perfectly sound, free from honeycomb and all other defects, quarry faced and fine axed in door jambs and in weathering and surface of coping and is to be shaped to the radius of the tower. Spaces are to be left for the inlet and overflow pipes where directed.

FOUNDATIONS TO TOWER.

CEMENT CONCRETE (6 to 1).—The cement concrete shall consist of one part by measure of Portland cement of quality specified, two parts of clean, sharp, coarse sand, one part of bluestone screenings broken to ¾ in. gauge, and three parts of broken bluestone, broken to 2 in. gauge, all to be mixed in a dry state, then thoroughly incorporated with the proper quantity of water, and used fresh.

The concrete shall be spread in layers of not more than 12 in. thick, and be thoroughly consolidated by ramming. When required, the concrete shall be closely packed round the castings, bolts, plates, etc., and finished in frames, where required, to the forms and dimensions shown by the drawings.

No masonry, brickwork, or ironwork must be commenced upon any concrete foundations until such foundations have been approved by the proper chief officer or the superintending officer.

Reinforced Concrete Tank.

Steel.—The steel rods are to be of the best quality, and of approved brand and make, tough and ductile, well and cleanly rolled to the full section, and free from scales, blisters, laminations, and defects of every sort. They are to have a tensile strength of not less than 27 tons, nor more than 31 tons, with an elongation of at least 20 per cent in a length of 8 in. and must stand being doubled over and bent flat on themselves without fracture. The rods shall present a clean surface to the concrete and be free from mud, dirt and other foreign substances. If the steel has more than a thin film of rust on it, it shall be thoroughly cleaned with wire brushes before being placed in the work.

The steel shall be placed in the forms accurately and secured against disturbances while the concrete is being placed and tamped, and every precaution shall be taken to ensure that the steel occupies exactly the position in the finished work as is shown in the drawing. The rods shall be well tied together at each intersection with No. 16 gauge wire.

Cement Concrete (5 to 1).—The cement concrete shall consist of one part by measure of Portland cement of quality specified, two parts blue stone screenings, all to pass a ¾ in. ring, three parts bluestone toppings to be mixed in a dry state and then thoroughly incorporated with the proper quantity of water and used fresh.

The concrete shall be a good wet mix and deposited in such a manner as not to cause a separation of the mortar from the coarse aggregate. The concrete shall be placed in the forms as soon as possible after mixing, and in no case shall the concrete be used if more than one hour has elapsed since the addition of its water. The concrete shall be deposited in horizontal layers not exceeding 12 in. in height, and thoroughly tamped with tampers of such form as the circumstances require. Before the placing of the concrete is suspended the joint to be formed shall be in such place and shall be made in such manner as the proper chief officer or the superintending officer may direct. Whenever fresh concrete joins the concrete that has set, the old concrete shall be roughed, cleaned and thoroughly slushed with a grout of neat cement and water.

Cement Rendering, Etc.—After the removal of the forms, the inside surface of the tank is to be roughened and cleaned, and the surface grouted with neat cement and rendered with ¾ in. of 2 to 1 cement mortar, composed of one part Portland cement and two parts of clean, sharp, coarse sand. The concrete shell of the tank is to measure 5 in. in thickness after inside rendering. All holes and blemishes on the outside surface are to be neatly pointed up with 1 to 1 cement mortar, and the whole outside surface washed down with a grout of neat cement. No pointing up or finishing the outside surface shall be done until the latter has been inspected by the superintending officer.

Pipes, Bolts, Fittings, Etc.—Provision must be made for building in as the work proceeds all bolts, pipes, ferrules, etc., for fixing the ironwork. Should it be necessary to bore holes in or cut into the finished concrete the authority of the proper chief officer must be obtained before so doing.

Forms.—The forms shall be accurately made and sufficiently substantial to preserve their shape, and shall be thoroughly tied and braced together,

and so supported from the scaffolding that the pressure of the concrete or the movement of the workmen and materials shall not throw them out of place. The forms shall also be sufficiently tight, so as not to permit of any of the concrete leaking out. All to the satisfaction of the proper chief officer or the superintending officer.

Before placing the concrete the insides of all forms shall be thoroughly cleaned of all dirt, chips, nails and rubbish of every description. The surfaces of all forms shall be covered with soft soap, mineral oil, or whitewash to prevent their sticking to the concrete.

The forms for the outside of the tank shall be of tongued and grooved boarding, dressed smooth, and covered with oil paper, canvas or other material, so as to present a smooth and even surface to the concrete. They are to be free from ridges, grain marks or other blemishes. These forms for the inside can be left rough. The forms are to be left in place for at least seven days, and for as much longer time as the proper chief officer or the superintending officer may direct.

Cast Iron.—All castings shall be made to the exact forms and dimensions shown on the drawings, or as approved by the proper chief officer, and all cast iron shall be of the best strong grey iron, clean in the skin, free from blow-holes, honeycomb, or other imperfections or impurities.

Cast Iron Test Bars.—The contractor is to cast, if ordered, with each and every casting of iron for use on the works of this contract at least one test bar, in the presence of the proper chief officer or the superintending officer.

Every such test bar is to be 3 ft. 6 in. long by 2 in. deep by 1 in. broad, and when placed on supports 3 ft. 0 in. apart, shall sustain a load of not less than 26 cwt. at the centre without breaking.

Wrought Iron Pipes.—All wrought iron pipes are to be best galvanized iron pipes, free from all defects, and provided with the necessary flanges, couplings, bends, insertion, etc.

Outlet.—The lower length of the down pipes is to be of No. 10 gauge steel, spiral riveted, 8 in. inside diameter, in one length, with angle iron flanges and insertion joints top and bottom. It is to be bolted to the cast iron footstep bend at the bottom, and to the cast iron reducing piece at the top. The pipe is to be dipped in an approved mixture of tar composition.

The upper length of the downpipe is to be composed of a cast iron reducing piece, a cast iron pipe with funnel-shaped mouth bottom of tank, and an expansion joint with a cast iron gland and stuffing box, a solid drawn brass tube and brass bushes. The whole is to be machined, turned, bored and bolted as shown on detail drawing.

Indicator Gear and Float.—The tank is to be provided with a galvanized wrought iron float working on steel rods fixed to bottom of tank. The indicator is to be fitted with all the necessary angle stays, wheels, brackets, chain, etc., fitted, fixed, and painted as shown.

Inlet Pipe.—The inlet pipe is to be of 3 in. galvanized wrought iron with all the necessary bends, bolts, straps, etc., shown. An approved 3 in. ballcock is also to be provided and fixed. The bend over the top of the tank is to be specially made to conform to the outline of the tank and to be galvanized after bending.

Overflow Pipe.—The overflow pipe is to be of galvanized wrought iron, with all the necessary bends, flanges, couplings, straps, bolts, tubes, etc. The pipe is to be bolted through the wall of the tower and side of tank, and is also to go through the hole made in the stone coping as shown on drawing.

Bolts Through Tank.—Where bolts are shown to go through the side of tank, they are to be enclosed in black iron tubes with flanges, washers and insertion as shown on detail drawing.

LADDERS.—Mild steel ladders are to be provided, fitted and fixed as shown.

DOOR TO TOWER.—The door is to be of Red Deal 2 in. thick, paneled and moulded one side, hung with three approved wrought iron butt hinges to solid Red Deal jambs. The jambs are to be secured with strong wrought iron holdfasts. The door is to be fitted with an approved carpenter's lock and provided with two keys. The whole is to be painted three coats of white lead and oil paint of approved tints.

PAINTING.—The whole of the steel and iron work in pipes, ladders and attachments shall be cleaned free from dirt, rust, etc., and painted one coat of the best red oxide of iron paint before leaving the contractor's yard, and after erection at the site with two coats of best red oxide of iron paint. Parts inaccessible after erection are to be painted before erection.

PATTERNS.—No casting shall be made from any pattern till such pattern has been inspected and approved by the proper chief officer or the superintending officer. All patterns will be provided by the corporation, and on the completion of the contract the whole of such patterns are to be put into proper repair, varnished, repacked, and delivered at the railway station nearest to the place where the castings are manufactured or at the Spencer street railway station yard by and at the sole cost of the contractor.

TESTING AND MAINTENANCE.—Fourteen days after completion the tank will be filled with water, the corporation making the necessary connection to the existing supply, and all the works of this contract will then be thoroughly tested and the whole must be shown to be in perfect working order to the satisfaction of the proper chief officer. The whole of the works are to be maintained in perfect working order in accordance with the provisions of clause 34 of the conditions of contract.

REMOVAL OF REJECTED MATERIALS.—On the completion of the works, the contractor shall remove all rejected pipes and materials from the premises of the corporation, and any such pipes or materials not removed by the contractor within seven days after service upon him of a notice from the proper chief officer or the superintending officer calling upon the contractor so to do may without further notice to the contractor be forfeited and shall without the contractor having any claim to payment in respect thereof become the property of the corporation.

DISCUSSION.

The President:—This is a report that has been continued from last year. If any member wants to discuss concrete tanks we will be glad to hear from him.

Mr. C. E. Smith:—I note a quotation from the engineer who says that the best results in getting water-tight concrete was by using a rather dry mixture. That is so entirely contrary to the experience I have had and the experiences I have read of others having, that it surprises me. Where I wanted concrete to be as nearly water tight as possible it has been my experience that the best results were obtained by using a very wet concrete and a very rich mixture, 1 : 1 : 2 or 1 : 2 : 3, rather than a dry mixture. If it is the recommendation, that a dry mixture be used in concrete construction, it is liable to mislead a good many men.

Mr. A. S. Markley:—Another point in work of that kind

where it is important to get a good mixture is that washed gravel or washed sand should be used at all times, eliminating all the clay possible. The least bit of clay in the concrete will spoil the job.

Mr. Reid:—I think concrete tanks should be waterproofed with a waterproofing mixture on the inside. I don't think one can depend entirely on making the concrete itself watertight. It may be made watertight in some cases, but a structure as important as a concrete tank should be thoroughly waterproofed on the inside with a modern method of waterproofing, as we do with our subways and bridge floors.

The President:—Did I understand Mr. Reid to say that in waterproofing he made an extra coating of some kind?

Mr. Reid:—I prefer an extra coating of some kind of waterproofing, some form of asphalt or other method of waterproofing in addition to that already specified of making a wet concrete and making the concrete itself as dense and as nearly impervious to water as possible. I would put the additional waterproofing on the inside.

Mr. Sheldon:—Mr. Smith and Mr. Markley brought out the question of the making of the concrete a very wet mixture. The Atlas Cement Co. has gone to considerable expense in making many experiments with different mixtures of concrete, as to its wetness or dryness. I think they claim, as a result, that a mixture can be too wet. If more water is put into the concrete than will be absorbed by the crystallization of the cement, it goes out and leaves a void. They have published a pamphlet on that particular point. I think that a mixture can be made too wet and it can be too dry to be impervious; there is no question about that.

The President:—Does any other member wish to say anything on this subject? It is very important.

Mr. Long:—In constructing the tanks at Sir John's Run and Chicago Junction, the contractors felt so sure that the concrete could be made water-tight, that they agreed that if we would allow them, they would make the concrete and guarantee it water-tight, but we insisted on their putting a concrete paint on the interior. The tank at Chicago Junction was built last winter. About the time they were finishing it, the thermometer went below zero and the tank was filled perhaps three or four days after it was finished. No water was drawn out for three or

four days, as we did not begin to use the tank as soon as we should have. The water froze and then some engines were sent there to take some of the water so it could be renewed. It was found that it has frozen so thick that, by the time they had taken out the water below the crust of ice and put some more on top, they could not get any water until they broke through this crust. We had a great deal of trouble for several weeks, until we finally ended up with having three thicknesses of ice at different points in the tank. When we finally thawed it out, it pulled out a lot of the concrete with the ice, which naturally allowed the tank to leak at these points. After it was thoroughly dried, we fixed it up and gave it a coat of waterproof paint. After that we had only a slight seepage which has disappeared since. Since that time we have built a tank at M. & K. Junction in West Virginia and guarded against the trouble we had at these other two points. We have here a very successful tank, which has not shown seepage at all. We painted it on the inside with a waterproof paint and rubbed it thoroughly on the outside with waterproof brick. This company used a metal form made for a certain diameter of tank and they fit so tight that they lose very little water. They don't make the mixture so wet that it has more than enough water. I think this gentleman said that a proper amount of water is just sufficient to mix the cement and have it thoroughly absorbed.

Mr. W. M. Clark:—I have never had anything to do with building concrete tanks, but I have been dabbling with concrete for a good many years, though never as an expert, and have used both dry and wet mixtures. There is danger in too dry a mixture. I believe that first class concrete can be made with what is known as a dry mixture, that is, use enough water so that when the concrete is thoroughly rammed, one can bring water to the entire surface. When that is done, it certainly must stand to reason that the concrete is thoroughly wet or else could not draw surplus water to the top. I think that the idea of a wet mixture was first originated to cheapen the labor on concrete, and in a great many cases I believe that we get too much water in. I have had some experiences with concrete repairs in wooden tanks. I have several such tanks that are holding water today, where if it had not been for these concrete patches new tanks would have been required. I have repaired tanks in this manner where the staves were practically rotted out. In one instance

one stave was rotted out for about 18 inches along the side of the stave. This was repaired two years ago, and when I passed it last Friday there was no leak evident. I think that I have either five or six tanks on my division that are repaired in that way.

Mr. J. Dupree:—I would like to ask Mr. Clark how he lines a wooden tank with concrete?

Mr. Clark:—This depends on where the leak is. I have stopped a leak in the bottom by spreading about two inches of very rich concrete over the bottom. If the leak is around the chime, I slope the concrete up to a distance of eight or ten inches, making the concrete probably four or five inches thick where the staves and bottom connect. In the instance where I spoke of the stave being rotted out, I built a form about three feet high to take in about ten inches of concrete and filled that. After it had thoroughly set, I took the form away and have never had any more trouble with it.

Mr. Andrews:—With your permission, I would like to make a few remarks on the subject. Mr. Clark's first experience in this work was with a tank at Lodi, Ohio, in 1902. He had an item on his program, "Rebuild the tank at Lodi," and when we inspected it he said "Now here is something I know you are going to give me, because that tank is liable to fall down before you leave here," and he was backed up by the division engineer. I said "If you will put four inches of concrete in that tank and four additional hoops on the bottom, you will make it stand for a year at least." He did that and continued placing it on his program until 1907 when we felt we had gone far enough and we authorized a new tank at that point. We erected the new tank. The then superintendent thought it was well to leave that tank there for storage; if it fell down, it wouldn't hurt anything, and in 1908, he had that same tank on the budget for a coat of paint.

Mr. Clark:—I want to follow this story up still further. I believe Mr. Andrews allowed the tank to be painted and it made such a good appearance, that, to the best of my information, it is standing there and holding water today.

Mr. Andrews:—That is an absolute fact, and I attribute the safety of that tank entirely to placing the four inches of concrete in the bottom. It was leaking badly and the chimes were bad. By placing the concrete in and putting additional hoops on the tank, it is standing today, ten years after, and it is on the program today for another coat of paint.

Mr. Clark:—The first time that ever I tried putting a concrete bottom in a water tank was in 1898, as an experiment. We had on the Pittsburgh & Western, with which I was connected at that time, a tank that was leaking very badly, and I conceived the idea of trying to fix it up with concrete. We did not think that the cement made in this country was good enough to patch a water tank with, so we got German hydraulic cement to patch the bottom of the tank and made a successful job of it,—so successful that the tank stood and remained in service until it caught fire and burned down.

Mr. Robinson:—Mr. President, I want to ask if the committee secured any prices on the cost of these concrete tanks?

The Secretary:—Costs will be found in the tabulated statements.

Mr. Long:—Those two 100,000 gallon tanks that we built cost in the neighborhood of $7,000 each. The ones at Roseburg and Sir John's Run cost in the neighborhood of $6,400 and the one at Chicago Junction cost about $7,200. I might add, in regard to using the space below the tank for a pump room—on account of the difference in the temperature outside and inside, we found that we had to take the pump out of the basement at Sir John's Run, because of the great amount of condensation that ruined the pump we had there, and we had to renew it.

Subject No. 7

REINFORCED CONCRETE CULVERT PIPE.

REPORT OF COMMITTEE.

While considerable information has been received on this subject, your committee does not feel that it has enough data to enable it to cover the matter fully and offers the following as a progress report, hoping that it may awake a wider interest in the subject and elicit information from other roads using concrete pipe, whose representatives among our membership have not yet been heard from.

The results of our inquiry among the members of the association and some railways not represented in our membership indicate that the use of reinforced concrete pipe is just being taken up, as out of 42 replies received, only 15 give any data in regard to the subject, and several of these indicate only a limited experience with this type of pipe. All using pipe of this description, however, are impressed with its economy and report favorably regarding it so that it promises to come into much larger use as a substitute for cast iron pipe.

Information has been received from representatives of the following roads using reinforced concrete culvert pipe:—Ark. S. E.; A. T. & S. F.; B. & O.; C. & N. W.; Cent. New Eng.; C. M. & St. P.; D. L. & W.; Erie; E. J. & E.; I. C.; P. R. R.; S. P.; and Wabash.

We understand the following roads also make use of concrete culvert pipe: C. B. & Q.; Soo; G. N.; N. P.; M. & St. L.; C. G. W.; C. R. I. & P.; C. & E. I.; K. C. S.; Q. & C.; Big Four; M. C.; L. S. & M. S.; C. P. R.; Grand Trunk; and M. & O.; we trust that their representatives will be heard from during the discussion of this subject in the convention.

Table A gives a synopsis of replies received from those who have used this kind of a culvert pipe.

In appendix A will be found extracts from some of the replies received from the committee's circular letter with plans and specifications furnished in some instances.

Fitness for Use in Embankments.

Several roads are already adopting this form of construction for standard culverts under fills of all heights. There is no difficulty in designing reinforced concrete pipe to meet all conditions of loading, to secure sections with diameters up to 48 in. whose weight will permit handling by the same methods by which cast iron pipe is placed. Several miles of such pipe are being laid on the C. M. & St. P., this summer in connection with double track and change of line. Concrete pipe is used instead of cast iron as far as the available supply permits, except in the extension of existing culverts or at points where the thinner cast iron pipe is more convenient, as in replacing a timber box culvert.

Possibly, in mountainous country where pipe would be laid on steep grades, the attrition of sand bearing water at high velocities might cause trouble with this class of pipe, by gradually scouring away the invert and exposing the reinforcing. Where timber trestles are being filled and the drainage area is such as can be cared for by a pipe, generally the most

TABLE A.

ROAD	CONDITIONS OF USE	KIND OF PIPE	INSIDE DIAMETER	THICKNESS
1. ARKANSAS S.E.	UNDER CONSIDERATION		18"	3"
2. A.T.&S.F.	SAME AS CAST IRON	MFR'S DESIGN	12" TO 72"	2" TO 7"
3. B.&O.	SAME AS CAST IRON	CIRCULAR, RAILWAY CO'S DESIGN	24"-36"-48"	4"-5"-6"
4. C.&N-W.	AVERAGE CONDITIONS	ELLIPTICAL SECTION	24"-36"-48"	2¾"-3¾" 4¼"
5. CENT. NEW ENG.	WHEREVER IRON PIPE IS USED	ELLIPTICAL SECTION	24"-36"	4"-4"
6. C.M.&ST.P.	WHEREVER IRON PIPE WOULD BE USED AND CONDITIONS PERMIT	CIRCULAR SECTION	24"-30" 36"-48"	4½"-5½" 4½"-5½"
7. D.L.&W.	UNDER ALL CONDITIONS EXCEPT WERE MINE WATER IS PRESENT.	CIRCULAR	24"-30"-36"	4"-4"-4½"
8. ERIE	UNDER ROADBED	CIRCULAR	20"-24" 30"-36"	2½"-4" 4"-4"
9. E.J.&E.	STANDARD FOR ALL PIPE CULVERTS IN PLACE OF CAST IRON UP TO 48" IN DIAMETER.	CIRCULAR SECTION	24"-30"-36" 42"-48"	5" FOR 24" 6" " 36" 6" " 48"
10. I.C.	AVERAGE CONDITIONS	CIRCULAR SECTION	36"-48"-60"	4" ALL SIZES
11. N.Y.W.&B.	LIMITED AMOUNT	ELLIPTICAL SECTION	48"	4"
12. PENNA.	SMALL AMOUNTS EXPERIMENTALLY	AM. CONC. PILE AND PIPE CO. CIRCULAR SECTION		
13. S.P.	ANYWHERE WITH MORE THAN 3' BETWEEN PIPE AND BASE OF RAIL.	PLAIN CONCRETE NOT REINFORCED	12"-18"-24" 30"-36"	2"-3"-4" 5"-6"
14. WABASH	WHEREVER IRON PIPE CAN BE USED	CIRCULAR RY CO'S DESIGN	24" TO 48"	4" ALL SIZES

Details Concrete Culvert Pipe, Various Railroads.

TABLE A.

	LENGTH	JOINT	WEIGHT IN LBS.	COST OF LAYING	PIPE MADE BY RY. CO. OR BOUGHT	PLANS & SPECIFICATIONS	AGE PIPE HANDLED
1.	3'	BUTT	660 PER SECT.	$1.50 PER SECT.	RY. CO.		7 DAYS
2.	3'	SPL.			BOUGHT	MFR'S. SPECFNS.	4 TO 6 WEEKS
3.	4'	BUTT JOINTS		$2.00 FOR 36"	RY. CO.	PLANS	3 TO 4 WEEKS
4.	8'	BELL		$1.45 PER FT. 2.05 " " 3.42 " "	MF'D BY CONTRACT, RY. FURNISHING MAT'L.	MFR'S DESIGN & CO'S. SPEC.	
5.	8'	BELL		SAME AS CAST IRON	BOUGHT	MFR'S DESIGN	4 TO 6 WEEKS
6.	6'	BEVELLED SHOULDER	2400 FOR 24" 3750 " 30" 3725 " 36" 5770 " 48"	DOES NOT VARY MUCH FROM CAST IRON.	RY. CO. SOME BOUGHT	RY. CO. DESIGN	20 DAYS IN SUMMER. 30 DAYS IN WINTER
7.	24"-10' 30"-8' 36"-6'	BELL		SAME AS CAST IRON	RY. CO.		7 TO 28 DAYS SHOULD NOT BE LESS THAN 2 WEEKS
8.	6'	BELL	219 PER. FT. 405 " " 490 " " 584 " "		BOUGHT	NONE	AS SOON AS DEL'D FROM FACTORY
9.	8'	BELL	24"-350 PER FT. 36"-525 " " 48"-700 " "		BOUGHT	MFR'S DESIGN	30 DAYS
10.	6'-4" FOR 36" & 48" 5'-4" FOR 60"	BELL			RY. CO.	RY. CO'S. DESIGN	
11.	8'	BELL	3 TONS PER SECTION	$1.50	BOUGHT	MFR'S. DESIGN & SPEC.	30 DAYS
12.					BOUGHT		
13.	3'	BELL & SPIGOT & ALSO BEVEL	100 200 350 530 780	SAME AS CAST IRON	RY. CO.	NONE	30 DAYS
14.	4'-8'	BELL	24"-56 PER FT. 36"-78 " " 48"-100 " "	$1.00 TO $2.00 PER FT.	RY. CO. AND ALSO BOUGHT	BLUEPRINTS FURNISHED	30 DAYS

Details Concrete Culvert Pipe, Various Railroads.

TABLE A.

	DEFECTS DUE TO FROST OR IMPURE WATER	JOINTS CEMENTED	TIME IN SERVICE	RELATIVE ECONOMY WITH CAST IRON PIPE.	GENERAL EXPERIENCE
1.	NONE	YES	5 YEARS	UNDER CONDITIONS OF HAUL AND BUILT AT SITE 1/10 THAT OF CAST IRON.	SATISFACTORY FOR THE SIZE MADE
2.		YES	2 YEARS		SATISFACTORY
3.	NONE	YES	3 YEARS	50% CHEAPER	SATISFACTORY
4.				25 % CHEAPER	
5.	NONE	YES	3 YEARS	CHEAPER IN FIRST COST & INSTALLATION	VERY SATISFACTORY
6.	NONE	NO	1½ YEARS	30% TO 50% CHEAPER	SATISFACTORY SO FAR
7.	NONE MINE WATER WILL CAUSE DISINTEGRATION	NO EXCEPT SPECIAL CASES	3 YEARS	CHEAPER THAN CAST IRON ABOVE 18", MORE ECONOMY AS THE DIAMETR OF PIPE INCREASES.	SATISFACTORY SO FAR
8.	NONE	YES	9 MOS.		LIMITED EXPERIENCE, SATISFACTORY SO FAR
9.	NONE	YES	1 YEAR	25% TO 40% CHEAPER	SATISFACTORY SO FAR
10.	NONE	NO	3 YEARS	50% CHEAPER	
11.	NONE	NO	1 YEAR	25% SAVING	FAVORABLE
12.			ONLY TRIED THIS YEAR	25% TO 50% CHEAPER	ONLY SMALL AMOUNTS BOUGHT THIS SEASON FOR EXPERIMENTAL USE.
13.	NONE	YES	10 YEARS	12"-40¢ 18"-50¢ 24"-70¢ 36"-$1.25	SATISFACTORY
14.	NONE	NO	5 YEARS	50% SAVING	SATISFACTORY

Details Concrete Culvert Pipe, Various Railroads.

economical opening to provide is a reinforced concrete pipe up to a diameter of 48 in. For openings larger than this some form of culvert built in place will be cheaper. The question of available material and length of haul will, of course, influence the type of opening used; however, an investigation showed that on the C. M. & St. P., even with carload tariff rates, a haul of 570 miles could be incurred and still make it economical to use the concrete pipe rather than cast iron. Aside from questions of cost, a properly reinforced pipe will be more apt to fail gradually in the event of breaking under the fill than will cast iron pipe. So far, however, no failures have been reported.

Types of Pipe.

There is considerable variety in the types of pipe used and in the general dimensions and manner of reinforcing.

For convenience in handling, the six foot section adopted by the C. M. & St. P. proves a desirable length and provides units of ready adaptation to varying heights of fill. Sections of this length up to 48 in. in dia. are readily unloaded from cars without special appliances. The thickness of the pipe depends on the character and disposition of the reinforcement. In one type of patented pipe the reinforcement is disposed of so as to be situated in the region of tension throughout, the section being elliptical. Pipe of this kind must be placed with its major axis vertical and while permitting the use of thinner walls, it is not as convenient to handle as circular pipe which does not require a special position in service.

Recent experience of the C. R. I. & P., in using the longer 8 ft. sections on new line construction involving considerable team haul and transfer of pipe would indicate that shorter lengths are preferable. On new line work on the C. M. & St. P. their standard pipe was found much more convenient than the bell jointed pipe of longer section bought outside; and it was found much more costly to place the oval pipes than cylindrical ones; especial difficulty being experienced in rolling the former into place over rough and wet ground.

Joints.

Most users of concrete pipe seem to adhere to the bell and spigot joints similar to those employed with cast iron pipe. One form of the joint used is a modification of the bell and spigot, the bell having the same external diameter as the balance of the section and the wall of the spigot end being tapered, with a band locking the reinforcing of adjacent sections together, the recess occupied by the band being afterwards filled with mortar.

A pipe designed by Messrs. Graham and Andrews of the B. & O., has three pockets recessed on the outside of the pipe which permit the wiring of anchors in adjacent sections together, the pockets afterwards being filled with mortar.

In the C. M. & St. P. standard pipe the ends are bevelled, with the portions adjacent to the outer and inner circumferences square. This results in a pipe with exterior and interior surfaces flush throughout its length when laid, insures an even bedding and greatly simplifies the forms required, as it reduces them to plane cylindrical surfaces, the bevels being formed by cast iron rings which serve to space the interior and exterior forms. A pipe having a uniform external diameter is much easier to handle and unload from cars and can be quickly rolled off while those having enlarged bells usually are loaded vertically, bell down, and are very cumbersome to unload on a main line without special equipment.

REINFORCING.

For the smaller sizes of pipe, some form of woven wire fabric seems to be used mostly with built up cages of light bars for the larger sections; a study of the plans submitted will best indicate the practice followed. For economy in handling, some form of reinforcing that will build up a stiff cage that can be handled and set in the forms without collapsing is desirable. In building the cables for the C. M. & St. P. type, experience showed that by wiring alternate hoops to the longitudinal reinforcement in opposite directions a stiff cage resulted, while if wired in the same direction, it readily collapsed when laid on its side. The specifications do not differ materially from those required in any other highly reinforced concrete construction, a 1: 2: 4 mixture with stone of 1 in. maximum diameter prevailing.

SEASONING, ETC.

A period of 30 days for curing before putting pipe in service seems desirable though in summer this may be reduced to 20 days. One manufacturer writes that he had trouble with pipe which were shipped when 10 days old due to the development of fine hair cracks and that they now would not permit their pipe to be shipped out until a month old.

Pipe can be unloaded by skidding from cars with snub lines and can be rolled down embankments with less danger of breakage than cast iron pipe. In some instances, pipe are simply dropped off the cars and allowed to roll down the banks. Methods in general are the same as those used for unloading cast iron pipe though some roads use derricks to handle the larger sizes.

Practice varies regarding filling the joints, some cementing them and others simply depending on the fit of the sections. It does not appear necessary under ordinary conditions.

Little information was received in regard to the type of forms used except that steel forms were considered superior to those of wood. On the C. M. & St. P., wooden forms were used when the manufacture was first started but these are being discarded as they wear out, and are replaced by steel forms of the company's own design, and which are proving very satisfactory. About one year's steady service was found to be all that could be gotten out of wooden forms and the steel forms are much more economical.

ECONOMY.

There is practical unanimity regarding the saving effected by the use of concrete pipe in place of cast iron, the relative cost depending on local conditions, but being from 25 to 50 per cent less. The economy is more marked with increase in diameter.

With cast iron at $28.00 per ton, and the market quotations for manufactured concrete pipe, the following shows the relative costs per lin. ft. for the two kinds:

	24 in.	30 in.	36 in.	48 in.
Cast Iron	$2.23	$3.33	$4.66	$8.26
Concrete	2.00	2.80	3.15	4.50

Very few railways have had concrete pipe in use many years. The Wabash have had pipe in service for five years and no failures have been observed, here or elsewhere where the pipe have been properly handled and placed.

L. D. HADWEN,
H. H. DECKER,
R. O. ELLIOT,
F. O. DRAPER,
F. E. KING,
G. LOUGHNANE,
Committee.

APPENDIX A.

EXTRACTS FROM LETTERS RECEIVED IN RESPONSE TO LETTER OF INQUIRY.

A. M. Van Auken, chief engineer, Arkansas Southeastern:—We had a piece of construction where we desired to put in something more permanent than wood boxes and we used reinforced concrete pipe solely because of cost. The freight charges made cast iron and vitrified pipe unduly expensive on that job.

Below are the estimated costs per lin. ft.:

Size	Cast Iron	Vitrified	Reinforced Concrete
12 in.	$2.44	$ .30	$ .24
18 in.	5.43	.69	.50
24 in.	8.13	1.41	1.04
30 in.	10.86	2.04	1.32
36 in.	14.63	3.41	1.65
42 in.	19.50		2.30
48 in.	23.56		2.75

On this work sand and gravel were of easy access, while cost of hauling was rather excessive.

J. F. Parker, general foreman, A. T. & S. F.:—We have been using reinforced concrete pipe for about two years for culvert work. The cost of laying per lineal foot varies a great deal according to the conditions. For instance, if the pipe is to be placed in a fill 10 or 12 ft. high, the largest expense would be in excavating and back filling. We build concrete end walls for this pipe, costing according to the number of yards of concrete in the wall and the size of the pipe. We handle the pipe by hand, lowering it off the car by means of ropes so as to let it down the bank easily. A pipe should not be placed under a fill until it has reached the age of from four to six weeks. It is our practice to fill joints. We have been using this pipe about two years and have not had any failures. The cost of the pipe is as follows:

12 in pipe	$ .65 per ft.
48 in. pipe	3.25 per ft.

The intervening sizes cost in the same proportion.

G. W. Andrews, inspector of maintenance, B. & O.:—Instead of using the form as designed by us we are arranging to use the forms as made by the Blaw Centering Company of Pittsburgh, Pa. No particular advantages are claimed for this pipe over that of the bell end concrete pipe, other than there is larger space at the joints to take care of pulling than there is in bell end pipe. We have made quite a lot of pipe of 36 in. diameter at a cost of $2 per lineal foot, which is approximately about one-third the cost of cast iron pipe and probably one-third less than the price paid manufacturers for concrete pipe.

G. W. Hand, assistant engineer, C. & N. W.:—This company uses reinforced concrete culvert pipe under average conditions. The pipe is made under the following specifications:

CONCRETE.

1 part Portland cement, 1½ parts torpedo sand, 1½ parts gravel or crushed stone passing ¾ in. ring. Tensile strength of concrete, after seven days in water, to be 175 lbs. per sq. in. at 70 deg. F.

REINFORCEMENT.

24 Inch Pipe:—No. 23 triangular mesh bent to circular form and adequately wired at splice with 6 in. lap. Longitudinal reinforcement to consist of 12 three-eighths in. bars spaced equidistant center to center and bent to extend into the bell and within 2 in. of the surface of the end.

36 Inch Pipe:—Transverse reinforcement consists of ⅜ in. corrugated bars spaced 4 in. center to center. These bars are bent to a circle and a splice made by lapping the ends 9 in. and wiring. Joints to be at quarter points. Longitudinal reinforcement consists of bars of the same size bent to extend into the bell, 12 in. bars being used. The bell is reinforced with two bars of the same size spaced 3 in. apart.

48 Inch Pipe:—Transverse reinforcement consists of ½ in. corrugated bars spaced 4 in. apart. Longitudinal bars of the same size, 16 being used. The bells are reinforced with two ½ in. bars spaced 3 in. apart. All laps in annular rings to be staggered.

The total cost of these pipes is as follows:

Size	Material	Manufacturing	Placing	Total
24 in.	$ .40	$1.70	$1.45	$3.55
36 in.	.62	2.60	2.05	5.27
48 in.	.86	3.85	3.42	8.13

This indicates that the cost of the pipe varies from 70 per cent in the case of 24 in. to 50 per cent in the case of the 48 in. size of the cost of cast iron pipe at $26 per ton. The cost of placing is greater than the cost of placing cast iron pipe. The loss from breakage is greater, but on the whole reinforced concrete pipe shows a saving over cast iron pipe of about 25 per cent in first cost. The question of durability has not been determined.

A. Montzheimer, chief engineer, E. J. & E.:—The E. J. & E. has adopted the use of reinforced concrete pipe for culverts in place of cast iron pipe for all openings where they will not be greater than 48 in. in diameter.

The diameters inside and outside are as follows:

Inside Diameter	Outside Diameter
24 in.	34 in.
36 in.	48 in.
48 in.	60 in.

The sections are eight feet long with bell and spigot.
The 24 in. diam. weighs 2,800 lbs., or 350 lbs. per ft.
The 36 in. diam. weighs 4,200 lbs., or 525 lbs. per ft.
The 48 in. diam. weighs 5,600 lbs., or 700 lbs. per ft.

On account of the weight of concrete pipe we have found it necessary to handle it with a derrick and work train. We have a 10-ton steam derrick in the bridge and building department that is used for this purpose. With cast iron pipe no work train service is required, as the pipe can be rolled from a flat car without danger of breaking and all sizes can be handled with a hand winch and tackle.

We have had concrete pipe in service for about one year without failure of any kind.

I quote the following note from W. B. Hotson, chief draftsman, under date of December 14, 1910:

"I find that for both the 36 in. and 48 in. pipe the medium weight cast iron pipe is the stronger, the 36 in. cast iron pipe being 1¾ times as strong as the 36 in. reinforced concrete pipe, and the 48 in. medium weight cast iron pipe about 1½ times as strong as the 48 in. reinforced concrete pipe. On the prints of the 24 in. reinforced concrete pipe there is not sufficient data for figuring its strength in that the amount of steel used is not shown."

F. O. Draper, superintendent of bridges, Illinois Central:—We have been using concrete pipe for the past three years with the very best results. I do

not think that we have had but one culvert that has caused any trouble. This was on a very heavy fill and was filled by plowing off the cars, the material dropping a distance of about 30 ft. We had one pipe which crushed; this proved, however, to be a defective pipe.

Before starting to use these pipes we had a test made at the University of Illinois of the strength of the concrete pipe, also of the cast iron pipe of the same size, 48 in. in diameter. The test was made by putting the joint of pipe into sand and tamping it thoroughly over the pipe, and by using hydraulic pressure for loading. The concrete pipe broke at 260,000 lbs. and the cast iron pipe, placed in the same manner, broke at 240,000 lbs. After the concrete pipe was broken it took the same load that it took to break the cast iron pipe, 240,000 lbs., before it went to pieces, which shows a considerable difference in strength between the two classes of material.

I believe that the concrete pipe is stronger and more durable and is about 50 per cent cheaper than the cast iron pipe. Of course, concrete pipe is more difficult to handle than cast iron pipe. In handling concrete pipe it is necessary in most cases to unload them with derrick cars and place them as near as possible in their final position with this equipment, as it is not practicable to roll them off cars the same as one would roll off cast iron pipe. I would not recommend installing this class of culverts smaller than 30 in., or larger than 60 in. In sizes below 30 in. it would be better and cheaper to use cast iron, and above 60 in. it is better to build a different style of structure.

E. Langford, acting chief engineer, New York, Westchester & Boston:—This company has used 1,800 ft. of concrete pipe with a diameter of 48 in. inside, and 56 in. outside, and a length of section of eight feet. The pipe had bell joints and weighed three tons per section. The cost of placing in the open trench was $1.50 per lineal foot. The pipe have been in service for 12 months and no failures have been observed. It shows a saving of about 25 per cent over cast iron pipe.

G. W. Rear, general bridge inspector, Sou. Pac. Co.:—We use non-reinforced concrete culvert pipe under all conditions where it is large enough to carry the water excepting that the pipe must be at least three ft. below the top of the tie.

We use pipe of the following sizes:

Inside Diameter	Outside Diameter
12 in.	16 in.
12 in.	24 in. special for drainage close up to rail.
18 in.	24 in.
24 in.	32 in.
30 in.	40 in.
36 in.	48 in.

The sections are 36 in. long. A modified bell and spigot are used and where the thickness of the wall is sufficient the bell is formed in the wall itself Where the wall is thinner it is flared out.

The approximate weight per 3 ft. lengths is as follows:

12 in.	300 lbs.
12 in. special	1,000 lbs.
18 in.	600 lbs.
24 in.	1,050 lbs.
30 in.	1,650 lbs.
36 in.	2,350 lbs.

The actual cost of handling and placing is a very small part of the job and is very little greater than for cast iron.

Concrete pipe costs us as follows, compared with the cost of cast iron pipe in the market:

Size	Concrete	Cast Iron
12 in.	$ .40 ft.	$1.80 ft.
18 in.	.50 ft.	2.80 ft.
24 in.	.70 ft.	4.00 ft.
36 in.	1.25 ft.	9.00 ft.

The cost of handling is not much greater than with cast iron. There is a little more excavation in a fill on account of the outside diameter of the pipe being larger and the pipe has to be handled a little more carefully. We have hundreds of these pipe culverts in all kinds of climate and they are very satisfactory.

W. T. Powell, superintendent of bridges and buildings, Colorado & Southern:—We have used a great deal of concrete pipe built in one piece on the ground and reinforced with woven fence wire. The cost is about as follows, including head walls, excavation and all material:

36 in. diam. 8 in. thick	$5.00 lin. ft.
42 in. diam. 8 in. thick	5.50 lin. ft.
48 in. diam. 8 in. thick	6.50 lin. ft.

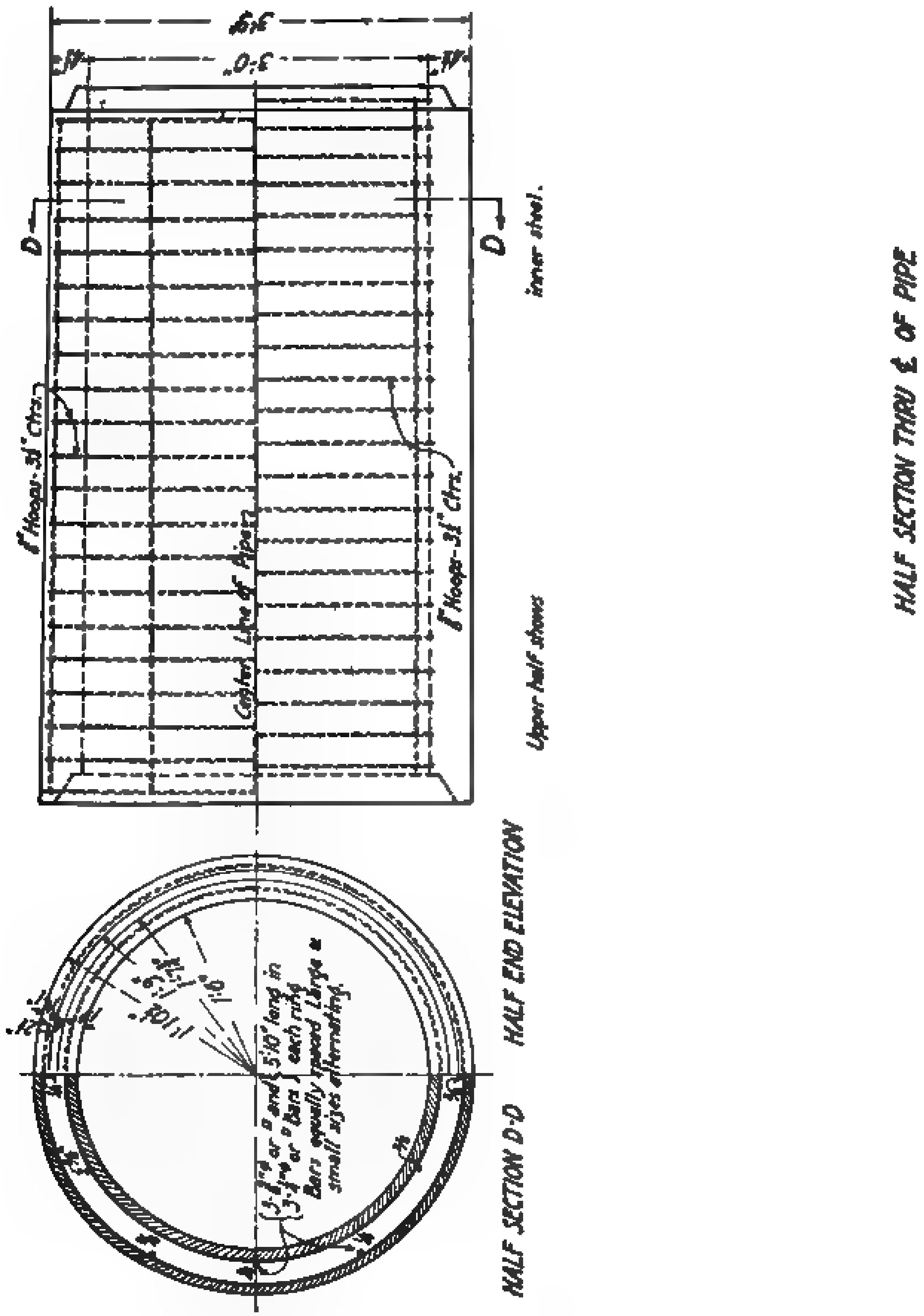
Oscar I. West, manager, American Concrete Pile & Pipe Co.:—We recommend that the pipes be loaded in such a way as to enable the section men to roll them from the cars, our belief being that pipes properly made and cured may be handled with much less danger of breakage than cast iron, simply by the use of skids and a snub line. We have had a standing offer to replace any pipes free of charge which have been broken in handling and we have never been called upon to replace any except in the case of where some pipes were shipped which were not properly cured.

It has come to our attention frequently that pipes are pushed from the sides of the car and allowed to roll down the bank without the use of any skids whatever, and so far as we know, with no injurious effect to the pipe. We have standing instructions with all our foremen not to ship pipes until they have had at least one month seasoning. In the summer of 1911 under stress of urgent appeals from railways to furnish them pipe, we permitted some to go out which had been cured but ten days. These pipes were sent out from three different plants to three different railways and the experience was the same in each case, namely, that the concrete appeared to be filled with fine hair cracks so that as soon as the pipe were put under a load they broke. We did not ship very many of them before discovering this and on giving them the proper time to season we had no further difficulty.

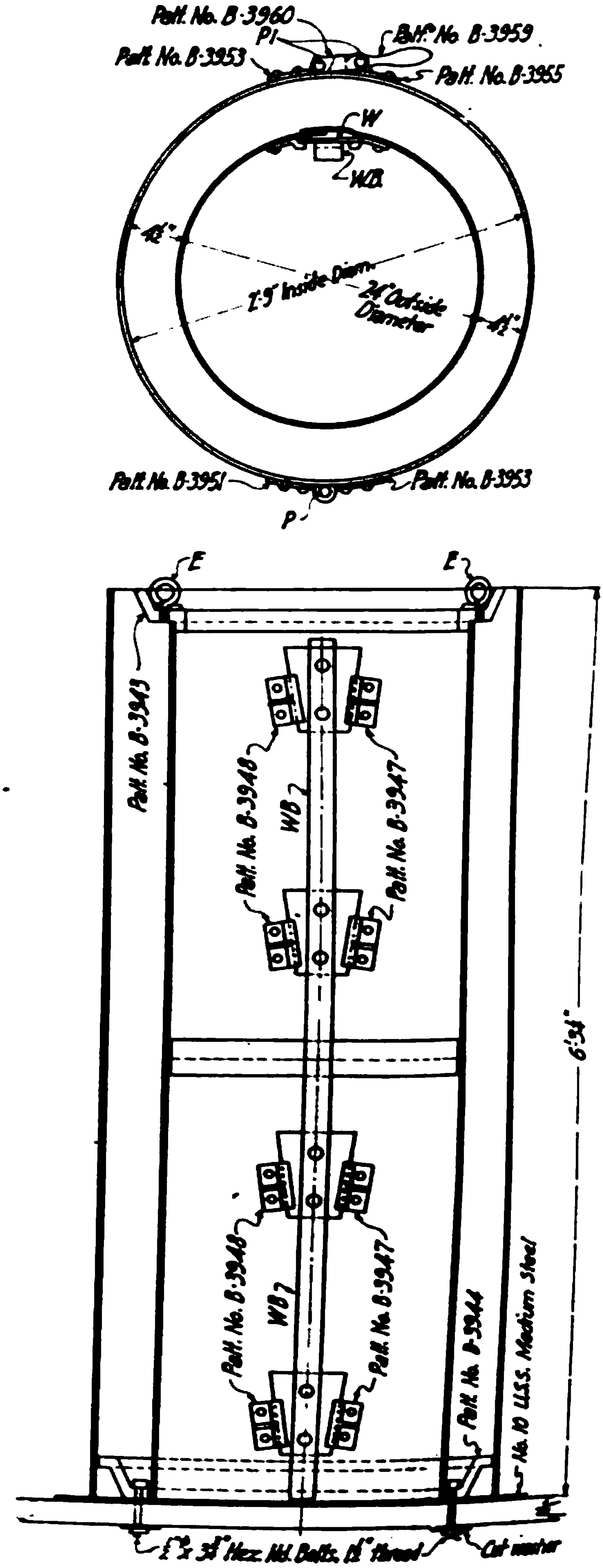
C. H. Cartlidge, C. B. & Q. R. R.:—We use reinforced concrete culvert pipe under all conditions where pipe is used. We buy some pipe, as well as manufacturing some of it ourselves. The methods of handling and placing concrete pipe are similar to those for cast iron pipe. Concrete pipe is handled and placed under fill after 30 days old.

We have not experienced any defects due to frost or the action of impure water. The joints are filled in some cases, especially where we expect the pipe to work under a head. Some of this pipe has been in service six years with no failures whatever. This company can show a saving of about $400,000 in six years over what cast iron pipe would have cost, prices taken yearly at the market rate.

We are constantly increasing our output of reinforced concrete culvert pipe and expect to build about 200,000 lineal feet within the next six or seven years. Our sizes run from two feet to six feet in diameter; sketch showing reinforcement is shown on page 105.

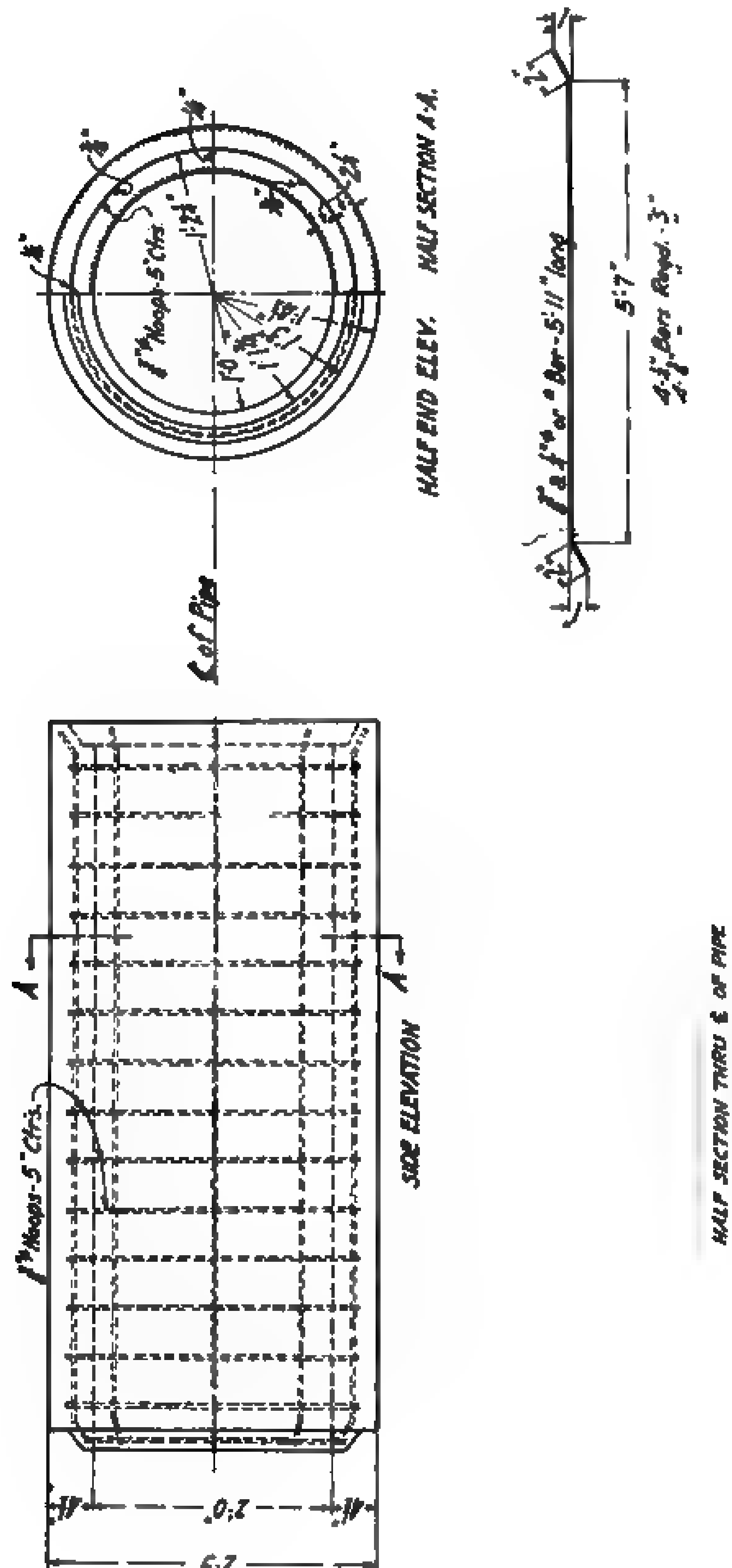


Heavy Reinforced Concrete Culvert Pipe, 36 In. Diam., C. M. & St. P. Ry.



Steel Form for 24-inch Concrete Culvert Pipe. C. M. & St. P. Ry.

Wooden Form for 42-Inch Concrete Culvert Pipe, C. M. & St. P. Ry.



Heavy Concrete Culvert Pipe, 24-Inch, C. M. & St. P. Ry.

APPENDIX B.

THE CONSTRUCTION OF CONCRETE PIPE BY THE C. M. & ST. P. AT TOMAH, WIS.

F. E. King, assistant engineer, C. M. & St. P. Ry.:—The question of making concrete pipe had been under consideration for some time but no definite move was made until July, 1911, when an experimental plant was started in Tomah, Wis. At first the plant was equipped with only two forms. These forms were of steel construction; one of them for 24 in. and the otner for 30 in. pipe. Later on three 24 in., three 30 in. and six 36 in. additional wooden forms were provided.

As the pipe are built in a vertical position, they rest on the form that moulds the spigot end of the pipe. It was therefore necessary to furnish about three times as many bottom plates as forms. These additional end forms were for the most part constructed of wood. One cast iron bottom plate and one cast iron top plate were however furnished with each of the steel forms. The construction of these forms is shown in the accompanying figures. Forms for other sizes are of similar construction. The wooden forms were lined with sheet steel of about 22 to 24 gauge, although this is not indicated in the drawing.

Other equipment consisted of a Smith concrete mixer, and a locomotive crane which handled the forms, removed the pipe from the working platform and took them to the stock piles. This however required only a short time in the early part of the day and the crane was engaged on other work around the yard having no connection whatever with the pipe plant the balance of the time. The arrangement of this temporary plant is shown in the plan reproduced herewith. The installation of this plant was begun July 12, 1911, and it was operated continuously until December 23, 1911. Provisions were made for housing the green pipe and keeping them warm while the weather was not too severe, but it was not thought advisable to carry on operations during the winter.

The pipe are circular in section with an effective length of six ft. The over-all length is six ft. 2½ in., the 2½ in. being used for the joint. The 24 in. pipe has a thickness of wall of 4½ in. and contains a single course of reinforcing in the center of the wall. The 30 in. pipe have walls 5½ in. in thickness with a single course of reinforcing in the center of the wall. The 36 in. pipe is 4½ in. in thickness with a double course of reinforcing. The 48 in. pipe are similar to the 36 in. pipe, except that the walls are 5½ in. in thickness. No 42 in. and 48 in. pipe were built during 1911. In 1912 however some forms for these sizes were furnished and pipe made, or will be made before the season closes.

The concrete mixture in all cases consisted of one part of cement, two parts of sand and 4 parts of crushed rock. The rock used consists of all the particles held on a screen with ¼ in. openings that will pass a screen with one in. openings. The reinforcing employed during 1911 consisted of ⅜ in. round deformed bars.

The output of the pipe plant for 1911 consisted of 327-24 in. pipe; 352-30 in. and 260-36 in. pipe; a total of 939 pieces of all sizes. The total yardage of concrete used in these pipe amounted to 770 cu. yds., the sacks of cement used 5,360; crushed rock, 632 cu. yds.; sand, 379 cu. yds. and gravel 106 cubic yards. The average number of sacks of cement per cu. yd. of concrete was 7.04 and the total pounds of reinforcing metal 111,845.

The force of men employed consisted of a foreman and seven men in July and was gradually increased from that number to a foreman and 17 men in December.

The work of preparing the plant for operation in 1912 was begun March 18th. The actual manufacturing of pipe however was not started until March 28th. Since that date, the plant has been operated continuously up to the 27th of September and will doubtless be continued as long as weather conditions permit. The following table shows the results of the 1912 work up to and including September 27th:

C. M. & St. P. Ry.'s Concrete Pipe Plant at Tomah, Wis., Showing Stock of Pipe.

PIPE MADE.

Month	24 in.	30 in.	36 in.	42 in.	48 in.	Total
April	87	85	135		4	311
May	90	84	118		41	333
June	199	75	91		36	401
July	130	77	56		54	317
August	154	88	22		124	388
September	107	60	16		76	259
Total	767	469	438		335	2,009

No 42 in. pipe were constructed up to this date as the forms for this size of pipe were not received until a later date. The equipment for 1912 was the same as that used in 1911 except that the concrete mixer used in 1911 has been replaced with a smaller machine driven by an electric motor and equipped with an elevating hopper; also most of the wooden forms have been gradually replaced with steel ones. At the end of September 7-24 in., 4-30 in., 1-36 in. and 4-48 in. steel forms also 2-48 in. wooden forms were in use making a total of 18 forms of all sizes.

During weather in which the concrete sets rapidly, it has been possible to make a pipe per day with each form. Under favorable conditions, with the present equipment it is possible to make 18 pipe per day.

It has been found that the wooden forms get out of shape and in the long run are not as economical as the steel ones. They are however satisfactory as a temporary expedient. They also have the advantage of being lighter to handle than the steel ones. This fact is of some value where the handling of the forms is done by hand. This advantage, however, is to some extent offset by the additional number of pieces to be handled and therefore the increased cost in time of setting them up.

It is the expectation to erect a permanent plant at Tomah for carrying on the manufacture of pipe for about nine months out of the year. This plant was to have been erected this year, but the pressure of other work has delayed the completion of the plans and the carrying out of the work. When complete this plant is to be equipped with labor saving devices to insure the maximum output for the least expenditure of labor.

APPENDIX C.

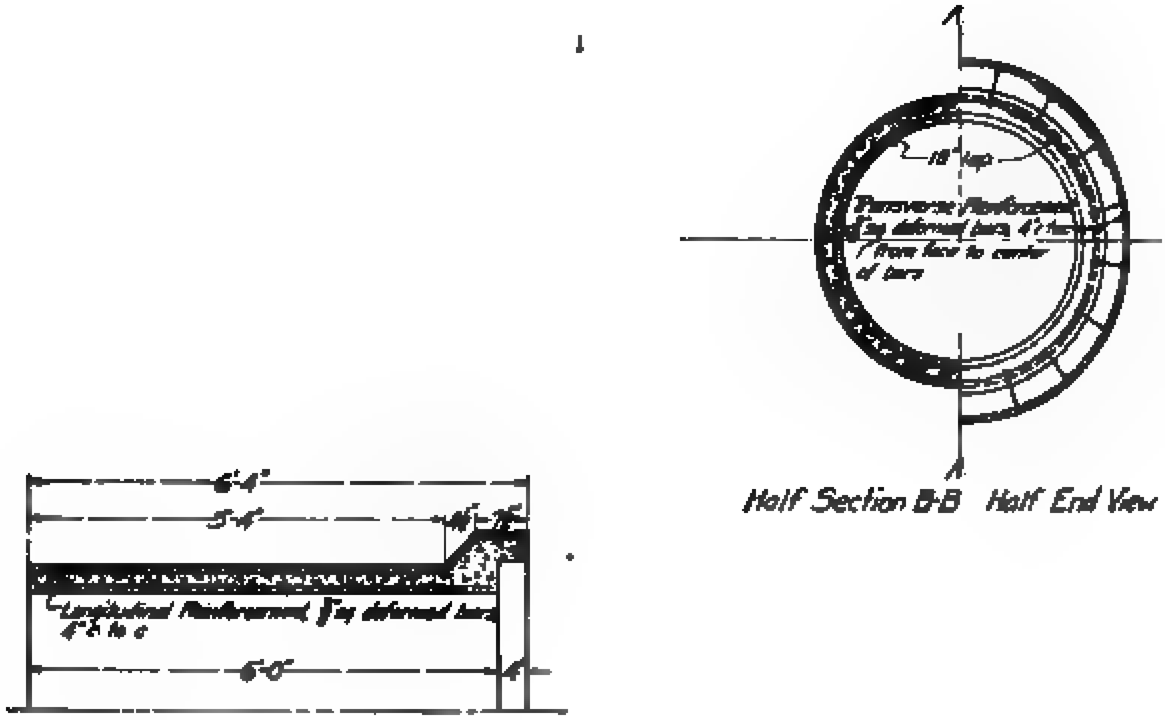
SPECIFICATIONS FOR REINFORCEMENT OF CONCRETE CULVERT PIPE, ILLINOIS CENTRAL R. R.

CEMENT:—Shall be of the brand or brands acceptable to and furnished in accordance with the specifications of the railroad company.

WORKMANSHIP:—Only workmanship of the highest quality shall be acceptable. Smoothness of finish and thoroughness of method throughout shall be required.

AGGREGATE:—The aggregate shall be of sand and crushed stone or gravel. All stone shall be a sound, hard clean stone crushed and screened so that none will pass through a sieve having one quarter inch meshes and so that all will pass through a screen having meshes one inch in diameter. All gravel shall be clean and free from dirt, and preferably graded in size from sand to pebbles about one inch in diameter. All gravel shall be of a size which will pass a one-inch screen. All concrete shall be mixed with the following proportions by loose measures:

Proportions of stone concrete—cement, 1½ bbl.; stone, 1 cu. yd.; sand, 0.45 cu. yd.; proportions of gravel concrete—cement, 1½ bbl.; gravel, 1 cu. yd.



Section A-A.

Reinforced Concrete Culvert Pipe. Illinois Central R. R.

Mixing:—When the amount of pipe is sufficient to warrant it, the concrete shall be mixed by machine. When mixed by hand the work shall be done as follows: The stone and sand or gravel shall be spread on a water tight platform to a depth of 6 in.; on this the cement shall be evenly spread and the mass turned till of a uniform color. Water shall be added sufficient to make a plastic mass and the whole turned over and over till thoroughly mixed.

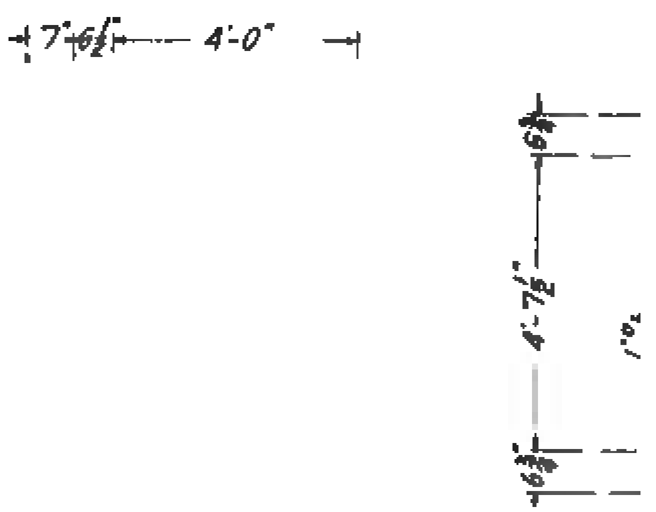
Deposition:—The most care shall be taken to prevent the formation of voids in any part of the pipe and to insure the thorough embedment of the reinforcement in its proper position until the concrete is placed around it. As the concrete is deposited, it shall be spaded or puddled along the lining of the mould on each face, so as to insure the smoothest possible finish. Every section shall be completely filled before any portion of the concrete has set.

Moulds:—The moulds shall be made true to plan and held rigidly in form during the process of depositing the concrete. They shall be lined with metal with all edges filleted and shall be well greased before each pipe is made.

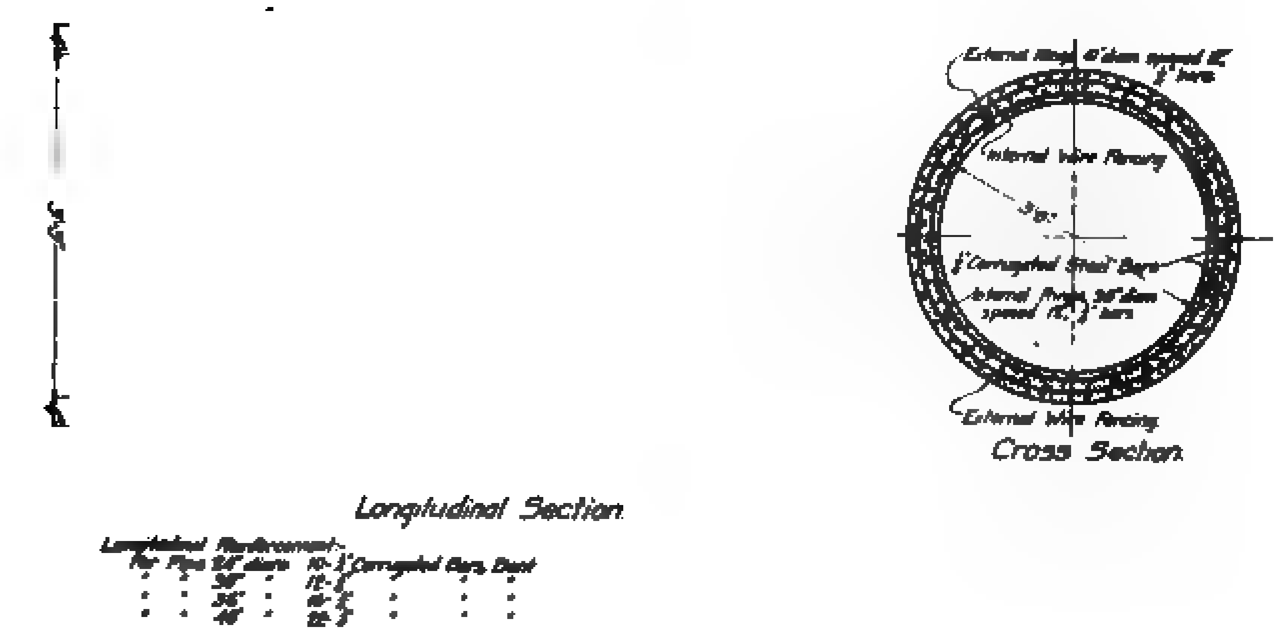
Reinforcement: 60 in. Pipe:—The transverse reinforcement shall consist of ½ in. square deformed bars of 50,000 lbs. elastic limit spaced not more than 4½ in center to center. These bars shall be bent to a circle and the splice made by lapping the ends for length of nine in. and tightly wiring them together. The joints shall be placed so that they will come at the quarter points or points 45 per cent from the vertical or horizontal diameters of the cross section of the pipe and shall break joints so far as possible. The longitudinal reinforcement shall consist of bars of the same section as the transverse bars and shall be spaced 9 in. apart if round or 12 in. apart if square. The longitudinal bars shall be suitably bent so as to extend into the bell and within two in. of the surface at the end. The bell shall be reinforced by two transverse bars of the same size as the others, spliced in the same way. The transverse and longitudinal bars shall be tightly fastened together so as to hold them in place during the deposition of the concrete.

48 IN. PIPE:—The transverse reinforcement shall consist of ⅜ in. square or round deformed bars of 50,000 lbs. elastic limit spaced not more than 3 in. center to center if round or 3⅞ in. center to center if square. The longitudinal reinforcement and the bending and splicing shall be as described for the 60 in. pipe.

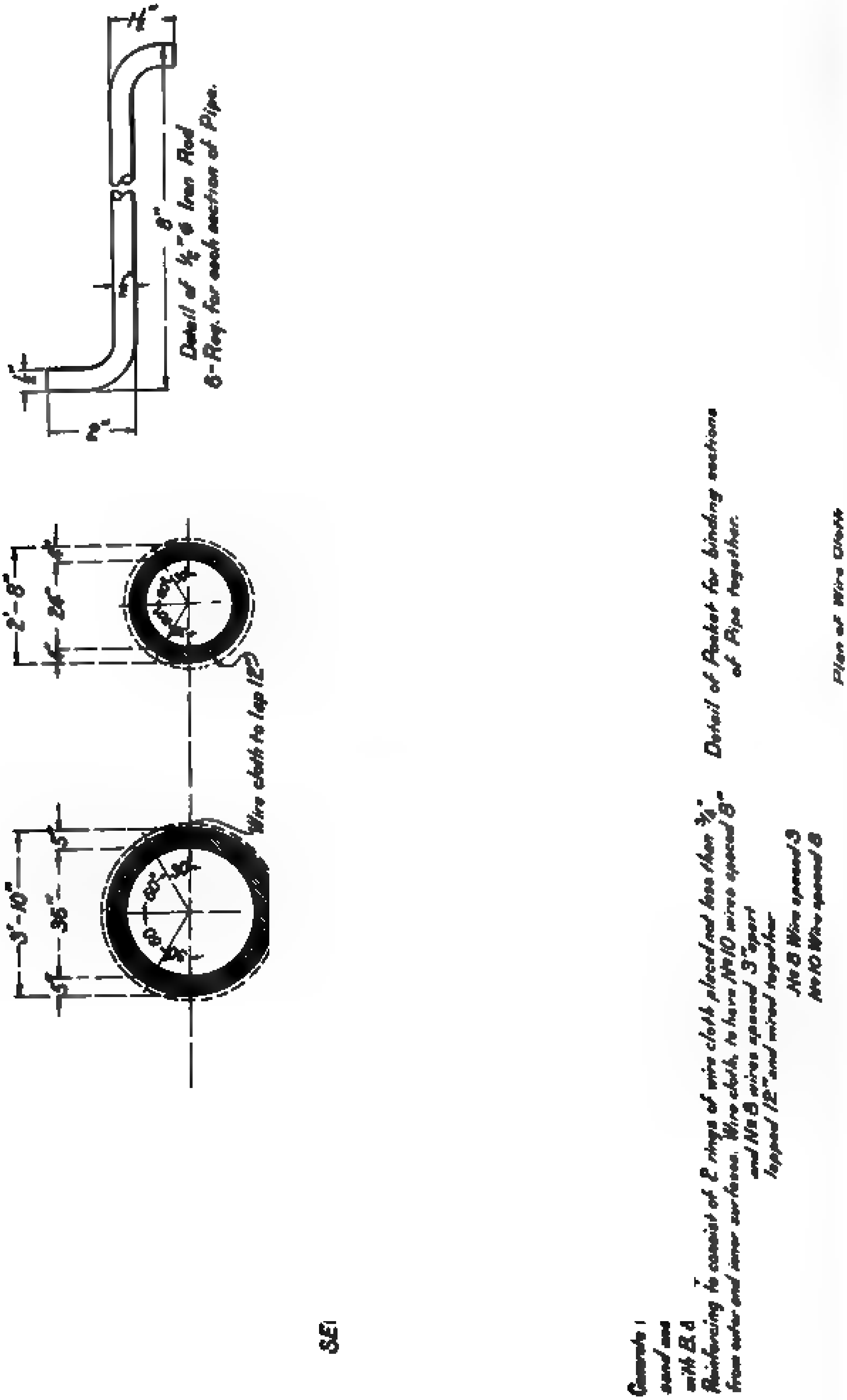
42 IN PIPE:—The transverse reinforcement shall consist of ⅜ in. square or round bars spaced not less than 3⅞ in. center to center if round, or 4¼ in. center to center if square The longitudinal bars shall be spaced 10 in. apart if round or 12 in. apart if square.



Reinforced Concrete Culvert Pipe, C. R. I. & P. Ry. and C. B. & Q. R. R.



Reinforced Concrete Culvert Pipe, Wabash R. R.



Reinforced Concrete Culvert Pipe B. & O. R. R.

36 IN. TO 24 IN. PIPE:—The reinforcement of these pipes shall consist of No. 23 American Steel & Wire triangular mesh bent to circular form and adequately wired at the splice with not less than 6 in. lap, together with ⅜ in. round transverse bars spaced 12 in. center to center. These transverse bars to be so bent as to extend into the bell and within two inches of the surface at the end. The reinforcement of the bell shall consist of 2⅜ in. round bars bent and spliced as described for the 60 in. pipe.

ALTERNATE PLANS FOR REINFORCEMENT:—A circular concrete pipe having two lines of reinforcement may be used in place of tne single line reinforcement, above specified, providing the pipe is of equal strength to that above specified and providing that in all cases the plan for the reinforcement, thickness of material, etc., is approved by the engineer.

DISCUSSION.

The President:—This report has been printed and distributed among the members; Mr. Hadwen is not here, but I think Mr. Decker is in the room and I would like to have him start the discussion.

Mr. H. H. Decker:—The committee on Reinforced Concrete Culvert Pipe sent out inquiries to a number of the roads and received replies from 42 different roads, only 15 of which gave much data in regard to the subject. We found from the data furnished that several of the roads were adopting this form of concrete construction for standard culverts under fills of all heights, and it was indicated that there was no difficulty in designing reinforced concrete pipe to meet all conditions of loading, to secure sections with diameters up to 48 inches. The types of pipe used by the roads varied somewhat. The six-ft. section was found to be used by most of the roads from which we received replies, although some used sections as long as eight ft. The bell and spigot joint generally used is similar to that on cast iron pipes. The reinforcing for the smaller sizes of pipe is woven wire fabric, and for the larger sizes, corrugated bars. A period of about thirty days is usually allowed for the seasoning of the pipe. These reports we have indicate that there is a saving of about 25 to 50 per cent in the use of concrete pipe over cast iron pipe. Very few roads have used concrete pipe for very many years. The Wabash has used such pipe for about five years which is, I believe, the longest of any road we had a reply from.

Mr. C. E. Smith:—I find on the Missouri Pacific that we can build reinforced concrete culverts three ft. x three ft. and up, cheaper than we can buy reinforced concrete pipe and we have

had quotations from a number of manufacturers. A three ft. x three ft. culvert has about the same cross section as a 42 in. pipe, which would seem to indicate that the culverts on our road and others would be cheaper from 36 in. down depending somewhat on the weight of the cast iron pipe the reinforced concrete is compared with. I have had men try to make comparisons with the very heaviest high pressure cast iron pipes, but I find that a standard cast iron pipe is satisfactory for our purpose and it is still lighter. We use a considerable amount of lock joint cast iron pipe. I have not been able to show any economy in the cost of reinforced concrete as against cast iron pipe, unless I assume considerable economy in the cost of installation and assume that it will not cost a good deal more to handle the concrete than the lighter cast iron pipe. As a great many members have had experience in putting in pipe, I would like to hear some comparisons in the cost of putting in concrete as against the cost of putting in cast iron pipe and also the cost of an equal area of each.

Mr. Reid:—We have had a little experience in placing concrete pipe on the Lake Shore, but we have used only 60 in. horizontal and 66 in. vertical diameter pipe which we make ourselves. The sections weigh about 7,000 pounds; they are six ft. long and the walls six in. thick. We handle them with our heavy capacity steam wrecking crane. I cannot say as to the cost, but they are rather expensive to handle and must be handled rather carefully. One cannot handle them as he can cast iron pipe. Cast iron pipe can be rolled off the car and down the bank, but concrete pipe must be lifted and placed with a derrick. We had some difficulty at first in placing them on account of getting the ropes right. We made a rope swing to go around the pipe and the pipe naturally settled down in the bed. In getting the rope off there was some displacement of the pipe. Recently we have made a hole in the top of the pipe, placing a rail through the pipe on the inside and have a bar or a loop through which the rail passed, fastened to the hook of the derrick. We can place the pipes in this way and be sure of keeping the vertical diameter vertical and having the joints connect. There is no disturbance of the pipe when we let go and remove the hanger. We have several of them in place and have had no trouble whatever with any of them. None of them have cracked. We have them under very heavy pressure and some of them reasonably close to the track.

We figure that they are cheaper than 60-in. iron pipe would be in those places.

Mr. Andrews:—Several years ago Mr. Graham, assistant engineer of bridges, our present engineer of bridges and myself designed a different type of concrete pipe. Up to this time we have used but little of it except the 36-in. size. This pipe is made without the bell and spigot ends in four ft. lengths, with the ends as near true as we could make them, in forms of our own design, made by the Blaw Centering Co. of Pittsburgh. Insets are provided instead of the bell and spigot which have a hook or a bar bent at each end which is cast or molded in the parts, projecting to about on a line with the outside surface of the pipe. The pipe is laid in a six-in. bed of cement which comes up about half-way of the middle diameter of the pipe. The pipe is then laid end to end and the hooks which are cast in the pipe are brought into line and wrapped with telegraph wire. After this is done the layer of cement is carried all the way around the joint. Our object in this is to get a tight joint and to keep it from pulling apart. We all know from experience the great difficulty we have had in cast iron pipe of bell and spigot design pulling apart, and how difficult it is to get it together after it once pulls apart. Mr. Taylor made some 36-in. pipe on the Cumberland division ready to place, at $1.79 per lineal foot. Our engineer on the B. & O. S. W., having no knowledge whatever of what Mr. Taylor had done, made the same sized pipe ready to put in place, for $1.80 a lineal foot. Mr. Turner has lately made some of the same sized pipe at Locust Point, for a fraction less than $1 a foot. Now, comparisons are not necessary at all between that price and the price of cast iron pipe, but are necessary between that price and the price of the bell and spigot concrete pipe as sold to us by manufacturers, of which the 36-in. pipe runs about $2.75 per lineal foot, or practically a dollar more than the highest price it has cost us to make it. There is no patent on the pipe, and we do not expect or desire to make one penny out of it. It is open to anyone that wants to use it. In cast iron pipe, we use rejected water pipe, commonly called culvert pipe, which is rejected pipe of any character that is unfit for use as water pipe, and is laid aside and sold as culvert pipe. The question of the thickness or strength of the pipe we use is governed entirely by how far it is to be from the base of the rail. We are not in favor of concrete pipe where it comes close to

the rail, but our general officers have given us instructions to use concrete pipe whenever possible when the distance is sufficiently far below the base of the rail to overcome any danger whatever of breaking.

The Secretary:—This report, I believe, does not deal very much with pipe in larger sizes than about four ft. and there is considerable pipe used in larger sizes than that. Perhaps some of our members, or some here who are not members, may know of pipe in use considerably larger. I would like to ask Mr. Camp if he has any knowledge of pipe considerably larger than 48 in., in service?

Mr Camp:—I have heard of pipe six ft. in diameter, but I cannot recall now where it is used.

The Secretary:—Mr. Howson, I believe, can give us some information on that.

Mr. Howson:—I happen to be familiar with the practice of the Burlington. They had established their maximum size at 48 in., up to about four years ago when they went to a 60-in. standard where the waterway demanded it. Since that time they have used large quantities of 60-in. pipe. They use the bell and spigot pipe. In some cases, where there is danger of its pulling apart, they have wired through from one end to the other to hold it. They have a plant of their own for manufacturing large quantities of it near Aurora, Ill. They find quite a large saving in the price of concrete over cast iron, in some cases as much as half.

Mr. Andrews:—I omitted to say that in designing this pipe we went into the question carefully of cost. While approximate. our estimates showed that when we got beyond 48-in. pipe, the ordinary concrete culvert was cheaper; so we designed our pipe making 48-in. the maxium and 24-in. the minimum.

Mr. Reid:—In investigating the matter on the Lake Shore. before we started using the large concrete pipe, we found that above 48-in. iron pipe, the ordinary concrete culverts were cheaper. I think that is true in the case of the 60-in. concrete pipe we are now using. We use a 60-in. pipe, with a circular reinforcement, and the six-in. increase in vertical diameter brings the reinforcement bars to the surface where they are needed,—on the inside of the pipe at the top and bottom,—and outside on the sides. In regard to the maximum size of concrete pipe used, the city of Detroit, a year or two ago, built a large sewer in Center avenue crossing under our tracks, in which they used seven ft.

reinforced concrete pipe with a sort of lock joint. The end of the pipe was bevelled, I think, on the inner and outer corners so it made practically a socket joint. After being put in place they were rotated enough to bring a lock into position so that the pipes were locked together.

Mr. Killam:—We have used a great deal of concrete pipe on the Intercolonial during the last eight or ten years. We have had no trouble with the joints pulling apart. Our concrete pipes are all made in four ft. sections with lock joints which lap three in. Wherever the foundation is at all doubtful or where it is inclined to be soft, a bed of concrete is placed. The larger pipes are made with a flat bottom and are then placed on this concrete bed with concrete alongside the pipe, making almost a double concrete pipe. At the sides of the embankment a concrete abutment is built over the ends to a solid foundation. With this construction we have never had a joint open in any pipe on the road. We never put in a pipe that had been made only two or three months, but we like to have them made the year before. We have never had any broken pipes since they went in and there are probably three or four or five hundred culverts. On one section of the road between Quebec and River View, a distance of 115 miles, the masonry was poor and had shaken to pièces. We replaced it with concrete pipe with abutments at the outer ends of the pipes and though we got cast iron pipes at the Londonderry Works for half price, the concrete pipes were found to be cheaper and to serve just as well as the iron pipes. For this reason we have stopped using the iron pipe altogether.

Mr. A. S. Markley:—The use of concrete is beyond the experimental stage. The only question is to get it properly mixed; for men will get careless and over-confident. We have a lot of concrete pipe still in the track that was put in previous to our taking the road in 1888 and it is still in good condition. It is about 18 in. in horizontal diameter, about 24 in. vertically and about 2½ in. thick and is joined together with a miter joint with no reinforcing of any kind.

Mr. W. O. Eggleston:—I have in mind a couple of concrete pipes that are 60 in. in diameter, made in three ft. sections, six in. thick, with bevel joints, under fast, heavy track and are only 18 in. below the base of the rail. I was rather suspicious of them when I first found them and have looked at them whenever in that neighborhood. Last winter I went through both pipes and

found them in perfect condition. The fill is composed of sand.

Mr. A. H. King:—I notice in this report under the subject, "Seasoning, etc.," a certain paragraph, "Pipe can be unloaded by skidding from cars with snub lines and can be rolled down embankments with less danger of breakage than cast iron pipe." I am wondering if that had been duly considered. I believe I have heard some of the members say that cast iron pipe could be rolled from cars down embankments with but little danger of breakage on ordinarily soft ground. That has been my experience. We do not take a great deal of care in rolling cast iron pipe from cars. I would like to ask if it would not be necessary in all cases to provide some sort of a foundation where the concrete is used in shorter lengths than cast iron, on soft ground? In other words, if there is any settlement the joints will, of course, open up and the usefulness and life of the pipe, as a means of carrying water, will be impaired.

Mr. Smith:—If concrete pipe in four, six or eight ft. lengths is used, there is much more chance of the weight being concentrated on a shorter length of culvert, in which case the short length is liable to go down in a soft bottom and it appears to me that the concrete pipe will be much more liable to get out of surface and break apart than 12-ft. lengths of cast iron pipe. That would seem to argue for the necessity of the foundation Mr. Killam tells about. The cost of such foundations should be added to the cost of the concrete pipe and taken into consideration in getting comparative costs.

Mr. A. S. Markley:—Mr. King referred to breakage of pipe in unloading. In the case of iron pipe,—if the spigot end is landed first it is not so liable to break, but if the bell end strikes first it is far more liable to be damaged.

Mr. Killam:—I never saw any iron pipe broken in letting it down, but I have seen a number of concrete pipes broken in unloading, perhaps carelessly or by accident. I have observed that they will nearly always break into four pieces.

Mr. Alexander:—This discussion is now coming where I am glad to hear it. We have been told how cheap this pipe was made and how it was taken in preference to cast iron pipe, but I believe that the expense of handling and distributing it should be added to the difference in cost. We have used considerable cast iron pipe on our road and it is in favor with us. I have seen the concrete pipe used by other roads and have seen failures with

it. As has been said, this pipe is made in short sections which are sometimes broken in distributing. Sometimes the foundation is not properly made and they go all to pieces. When one adds the cost of making a good foundation and the extra cost of distributing, to the price, he is coming close to the cost of cast iron pipe. As we are in a timber country, we build wooden culverts, largely, on construction. These culverts are built large, so that we can replace them afterwards with cast iron pipe or line them with concrete built in place, which is preferable to any pipe with us. We use cast iron pipe in 12-ft. lengths and half lengths, with the bell and spigot joint up to 36 in., but then we find it is cheaper, as a rule to build concrete in place. We have some 48-in. pipe in special cases and we run down to 12 or 10-in. cast iron pipe. We can distribute our pipes very readily, with no breakage. We hardly stop the train to do it, because a freight train may run slow enough to allow pipe to be rolled off if there are no sticks or rocks for it to strike on. In my estimation this is the cheapest pipe with us, although I have been, perhaps, somewhat prejudiced against the concrete pipe.

The Secretary:—It is true that if the ground is soft any kind of a culvert will require some extra attention and expense in the matter of foundations. The extra expense for the foundation for concrete pipe should be but a very little more than that required for iron pipe. The Chicago & Northwestern has during the past few years rebuilt hundreds of waterways, using concrete culvert pipe, where wooden boxes or trestles formerly existed, and the saving over that if iron pipe had been used would amount to thousands of dollars. I think I am safe in saying that the cost of construction of concrete pipe culverts is from 30 to 40 per cent cheaper than when constructed of cast iron. Concrete pipe, properly made, ought to last many years but just how its life will compare with that of iron pipe time alone will determine.

Mr. King:—I want to confine myself to the subject and talk on concrete pipe, although, as a comparison, I favor the cast iron and we use it altogether on that part of the Harriman Lines with which I am familiar. I have yet to find where there has been any trouble from any kind of culvert pipe pulling apart, providing the foundation was perfect and there was no settlement.

The Secretary:—I would like to ask Mr. King if he puts end walls on any of the culvert pipe?

Mr. King:—Yes, we provide end walls as a rule and use end

walls where we have irrigation pipes. We make a distinction between the drainage culvert and irrigation culvert. In our country we have a great many irrigation culverts and end walls are put on mainly to prevent possible leakage outside the pipe. Frequently, where there is considerable fall at the lower end, a culvert washes and leaves the lower end unsupported. We then put in end walls which I think assists in holding the joints together. It is our common practice to use end walls.

The Secretary:—I asked Mr. King that question because many roads use end walls for all of their pipes. In case of a sliding bank, where the center of the embankment may be solid, the pressure of the sliding material against the end walls crowds them out, thus pulling the pipes apart at the joints.

Mr. Alexander:—We had iron pipes pull apart where the joints did not settle, and where there were no end walls. We have a good deal of frost in our country and some very sticky clay. If the fill is of new construction, it is likely to settle. The clay freezes solid to the ends of the pipe, and if a settlement comes while the clay is still frozen it will pull the pipes apart. We don't use an end wall as a rule, on a pipe, although we have put some end walls on tile pipes. The result has been that in some cases the clay has pulled up the end walls and broken the pipes, and we had to take them up. I would rather have pipes without any end walls on them unless they are necessary to keep the clay from running into the pipes.

Mr. Penwell:—I have never made any concrete pipes but there is one on our railroad that was there in 1900, when I became connected with this line. It was built with miter joints in three ft. lengths without any reinforcing. It is within 18 in. of the base of the rail and is in perfect condition. I expect every time I go there to find it flattened out and broken down, but it stands.

SUBJECT No. 8.

THE CONSTRUCTION AND MAINTENANCE OF LONG PIPE LINES FOR LOCOMOTIVE WATER SUPPLY, INTAKES, PIPE-LINES, PUMP-PITS, RESERVOIRS, ETC.

REPORT OF COMMITTEE.

Considering the subject in a general way the construction of a reservoir or dam depends largely on the existing conditions at the desired location. Where it is in a rock formation, such as is found in mountainous territory, concrete is the better material to use in the construction of a wall. This wall must be of sufficient size to withstand the maximum pressure of flood waters and to safely hold the required body of water to be impounded.

Where the formation is of soil and bed rock is at a depth such that concrete would be too expensive, a dirt reservoir can be constructed to impound the water very successfully. In this case the bank must be made not less than 10 ft. wide at the top and have a long slope on the outside which should be sodded with some grass that will grow successfully in that part of the country. A grass like Bermuda grass which is hardy and mats closely has been found to be the best in Arizona to keep the bank from washing. On the inside of the reservoir it is a good practice to cover the slope with gravel of sufficient coarseness to prevent the washing of the bank by the waves created by the winds. Where the soil is of a porous nature allowing the water to percolate through it, a stiff clay placed over the interior surface and well puddled will make the reservoir absolutely impervious to water. A convenient way to puddle a dirt reservoir is to corral a band of sheep for several nights in the reservoir when the clay is in a pliable condition. The sharp hoofs of the sheep will pack the clay better than any other method that can be applied. Cattle will do the same but not as effectively.

Pipes leading from reservoirs should be placed about 12 in. or a little more from the bottom and carried outside the wall to a pit of sufficient size to admit a man going down inside and working. A valve should be placed in this pit on the line leading from the reservoir into the pit and another valve on the supply pipe line. The pit should also have a depth of two feet below the intake pipe to allow any solids that may be drawn out of the reservoir to be removed, thus preventing their getting into the supply pipe line. In all lines leading from the reservoir through the wall great care must be used especially in a dirt wall to prevent any leakage by placing some suitable material around the pipe line, as no matter how small the leak is at first it is liable to develop at any time and utterly destroy a portion of the structure.

It is usually the case that water impounded for gravity supply has to be carried a long distance to the point of use through pipe lines. If such is the case, the ground for the pipe line should be carefully gone over and a survey made to endeavor to locate the line on an even grade without going into depressions or over rises. Where this is not possible air valves must be placed at all high points in the line to allow the air to escape, as the air will always rise to the highest point and if not allowed to escape will retard the

flow of water and eventually stop it altogether until the air is released. There are many air valves on the market and care should be exercised in the selection of the proper kind so that the attention necessary to keep in condition will be greatly reduced and less failure will occur in the water supply.

The selection of the pipe best suited for the pipe line depends largely on the nature of the soil. This must be considered in view of its chemical contents so as to provide the proper kind of pipe to withstand the corrosive action of the soil in which it is to be laid, some soil being so bad that it is necessary to use wooden pipes, which are used successfully for a great many years while in the same soil iron pipe will last but a very short time. A paint or dip put on the pipe will prevent corrosion for a great many years in some soils if properly applied. Asphalt dip is one of the best and when put on properly will keep the soil from getting at the body of the pipe for years. A satisfactory method is to dip the pipe in asphalt at the proper temperature, the pipe also being heated. After the first coat roll the pipe in sawdust and when hardened dip again. In this way a coat of asphalt over 1/8 in. thick will be taken on which will withstand the action of the soil for a long time.

A tee with a plug or a valve looking down should be placed in pipe lines leading from reservoirs at intervals along the line so that the line can be opened and the accumulation of foreign matter that may be in the pipe may be flushed out. If this is allowed to remain it will gradually decrease the carrying capacity of the pipe line to a very considerable extent and lines have been known to fill up entirely from an accumulation of silt in a few years.

The expansion of long pipe lines has to be taken into consideration and the regular expansion joint of about six inches transverse should be placed according to the varying temperature of the locality. Pipe lines should be placed underground at a sufficient depth to protect them from the action of frost or extreme varying temperature.

In the construction of a pipe line the first thing to be done is to prepare the ditch properly. The ditch should be dug to such a depth that the pipe will be below the frost-line when covered. This depth will vary according to the climate where the line is located. The trench must be level, or even on the bottom so that the pipe will lie firmly on the ground, otherwise it will settle, and cause leakage. This precaution is especially necessary when laying wooden pipe which should be driven firmly together, but care must be used to see that the joints are not forced too hard, as this tends to split the tenons away from the pipe. When backfilling, the utmost care should be used in tamping around and under the pipe so that no settling will take place, otherwise the pipe will settle both out of line and out of round.

The chairman found these measures necessary from personal experience, in laying 135 miles of pipe on what is known as the Bonito Pipe Line, for the El Paso & Southwestern Railway. On this work the greatest trouble with leakage resulted from irregularity in laying and backfilling.

Mr. J. L. Campbell, engineer in charge, found by investigation, that wood pipe under a pressure of 130 lbs. would give satisfactory service for 25 years, on which basis it was less expensive than cast iron and was therefore used. Cast iron was considered preferable to steel for pressures not exceeding 310 lbs. on account of its greater durability.

The following information concerning the Bonito pipe line is taken largely from a description by J. L. Campbell in the Proceedings of the American Society of Civil Engineers, Vol. LXX, Dec., 1910:

Wood Pipe:—Machine made, spirally wound, wood-stave pipe, made in sections from 8 to 12 ft. long, with the exterior surface covered with a heavy coat of asphalt, was selected in preference to unprotected continuous stave pipe as the diameters were not so great as to require the latter. The pipe is wound with flat steel bands, of from 14 to 18 gage and from one to two in. wide. The machine winds at any desired pitch and tension. At each end, the spiral wind is doubled back two turns, the second laying over the first and developing a frictional resistance similar to that of a double hitch of a rope around a post. The ends of the bands are held by screw nails or a forged clip, the latter being the better. This clip has two or three spikes

on the underside which set into the stave and two side lugs on top which turn down over the band. The latter pass twice over the seat on the clip, the first turn holding the clip to the stave while the second turn is held by the lugs, which are hammered down over it. The end of the band is then turned back over the clip and held down by the staple.

The staves are double tongued and grooved and from 1⅜ to 2 in. thick. The smallest thickness is sufficient. The exterior face of the staves should be turned, concentric with the axis of the pipe to form the circle so that the band will have perfect contact with the wood.

The joints are formed by turning a chamber in one end of the pipe, and a tenon on the other, or both ends are turned to a true exterior circle and driven into a wood or steel sleeve. The tenon and chamber were used in this work. Finally, each piece of pipe is covered with as much hot asphalt as it will carry.

Steel Bands:—The specifications required bands of mild steel of 60,000 lbs. strength, with an elastic limit half as great. The winding was spaced to limit the tension to 15,000 lbs. per sq. in.

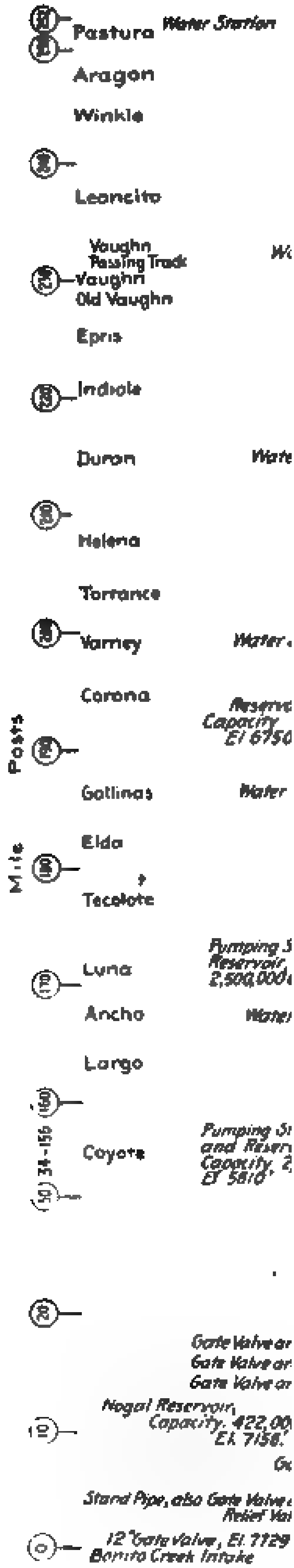
If severe water hammer is present, the ordinary working stress should be materially less than the latter figure, otherwise the spiral bands will stretch enough to permit the water to spurt out between the stays. This was determined to be true on 4,500 ft. of 12-in. pipe connecting the Carrizozo reservoir with the water column at the round house there. In pumping tests at the mills, attempts were made, at various times, to burst the pipe, but they never succeeded. Before the elastic limit was exceeded, the water was running out between the staves as fast as the pump forced it in. On the following day, the pipe thus tested would carry the pressure for which it was designed. Except for defects in bands, pipe of this kind will not burst in the service for which it is properly designed. This is true, without exception, of the 100,000 pieces in this service.

Wood Staves:—The staves of this pipe are of Michigan and Canadian white pine. This pine cannot now be had of clear stuff, or in long lengths, in large quantities; otherwise, it is unexcelled. Douglas fir and yellow pine, coarser and harder woods, have the advantage of clear lumber and long lengths. Cypress is not as plentiful and redwood is costly. The mill tests did not determine definitely the minimum degree of seasoning necessary, and press of time compelled the acceptance of some rather green lumber. Service tests do not show that there is any abnormal leakage from pipe made of such lumber and it could not now be distinguished in the trench by such tests. Undoubtedly, however, thorough air seasoning should be required.

Bored Pipe:—Owing to its small size, a part of the 3½ in. pipe was bored from the log. This was a mistake, for bored pipe has a rough interior and a reduced capacity. The inspection and culling are difficult and unsatisfactory and imperfections readily apparent in a stave frequently escape detection in bored pipe.

Pipe Joints:—The chamber and tenon of this pipe is an all-wood joint 4 in. deep. An iron sleeve makes a better and stronger joint as it compensates for any initial tension in the banding over the chamber of the wood joint, and secures full advantage of the swelling of the wood. Cast iron is better than steel, as it is more rigid and its granulated surface breaks up the smoothness of the wood surface swelling against it. One objection to the cast iron sleeve is that of cost, but it adds 4 in. to the effective length of every section of the pipe as compared with the wood joints. On the Pacific coast, the banded wood stave sleeve is used with success.

Coating:—To preserve the banding from corrosion and the wood from exterior decay, the pipe is thoroughly dipped in refined asphalt, having a flow point adjusted to the prevailing temperature during shipment and laying. One grade can be used through a considerable range of temperature, as the coating used on this work endured a 2,000 mile shipment successfully.



Note: Pipe Line reaches Railroad at Coyote N.M. and parallels Track on Right of Way to Pastura, N.M.

Condensed Profile of Bonito Pipe Line, Bonito Creek to Pastura, New Mexico, El Paso & Southwestern System.

Each piece was carefully inspected along the trench and any break in the coating was thoroughly painted with hot asphalt, enough of the latter being sent from the factory in barrels with the pipe. The first 37 miles of this pipe has been in service for four years. Recent inspections show the coating to be in excellent condition and the steel underneath to be bright and clean, although in some cases, where the initial pressure and leakage between the staves of the dry pipe were great, the escaping air and water lifted the coating into bubbles. At some points where the lifting was great enough to rupture the asphalt and the soil is heavily charged with alkali some corrosion has begun.

The integrity and impermeability of this asphalt coat are quite as vital as constant saturation as this coating protects the entire pipe from exterior contact with destructive agencies. With such effective exterior protection a constantly full pipe is not so imperative. In the exterior protection of the wood, this coated pipe has quite an advantage over continuous stave pipe.

Cast Iron Pipe:—Beginning at the first pumping plant at Coyote at mile 156, and running up to mile 166 and again commencing at Luna pumps, mile 171 and extending up to mile 179, the minimum pressure on those portions of the pump main is more than the 130 lbs. per sq. in. allowed for wood pipe, and the final estimated maximum pressure ran up to 310 lbs. The selection of pipe for these pressures was first between steel and cast iron and, second, between the lead joint of the standard bell and spigot pipe and the machine iron joint of the universal joint pipe. Again the choice was between lead and leadite, for the bell and spigot pipe. Cast iron was selected because of the certainty of its long life and the bell and spigot pipe was selected on the basis of comparative cost of pipe laid. The standard lead joint was chosen on the result of tests. This cast iron pumping main has a diameter of 12 in. throughout.

Pipe Joints:—There was a question of the reliability of lead joints at 300 lbs. pressure. A section of 12 in. pipe was laid with standard joints containing 22 lbs. of lead and tested up to 500 lbs. pressure without a sign of failure or leakage. The joints were caulked down 3-16 in. below the face of the bell. Of the 8,700 joints thus made in the field, not one has blown out or failed. A few leaked slightly on top and they were made permanently tight by additional caulking. The present maximum pressure is 278 lbs. These joints are standard joints specified by the New England Water Works Association. It should be borne in mind that there is no water hammer in this line. In 8,700 joints, 198,000 lbs. of lead and 3,200 lbs. of oakum were used, or 22.76 lbs of lead and 0.37 lbs. of oakum per joint.

Leadite was tested in competition with the lead but it leaked at 100 lbs. and failed under a sustained pressure of 300 lbs. It is a friable material and cannot be caulked successfully, while its principal ingredient appears to be sulphur. The failure was by slow creeping out of the joints. It is melted and poured, but not caulked. It has attractive features for low pressures and for lines not subject to movement or heavy jarring.

Air Cushions:—To prevent water hammer on the pumping main, all pumps are provided with large air chambers. In addition, and as a special feature for absorbing the shock of pumping under a high pressure through a pipe 21 miles long, a large air chamber in the form of a closed steel cylinder, 5 ft. in diameter and 15 ft. long is mounted on the pumping main outside the pump-house. This cylinder is set on its side with concrete collars, directly over the pipe beneath, to which it is connected by a 12 in. tee, in which a 12 in. gate valve is set. The cylinder is provided with a glass gage cock, etc., and was designed for a working pressure of 3C0 lbs. It has proved to be entirely air and water tight. As indicated by sensitive gages on the pump main, just beyond these large air chambers, the latter absorbs all the water hammer which gets beyond the air chamber, on the pumps.

Pumping Plants:—The pumps at Coyote and Luna are Nordberg-duplex, cross compound, condensing, crank-and-fly-wheel machines, with six-inch

plungers, traveling 600 ft. per minute, at full normal speed, and designed to work again at 300 lbs. per sq. in. They have a guaranteed efficiency of 135,-000,000 ft. per 1,000 lbs. of steam at 150 lbs. and super-heated 75 deg. One hundred twenty-five h. p. Sterling water-tube boilers are used, with Foster super-heaters and 33-in. stacks, 100 ft high. Each plant is provided with complete duplicate pump and boiler units, only one set working at a time. The pump building is a substantial concrete brick and steel structure, 50 ft.x80ft. in plan, with a fire wall, with two steel doors, dividing the floor space into an engine room 50ft.x50ft. and a boiler room 50ft.x30ft. The two plants are exactly alike.

Pipe Line Leakage:—There is no measurable leakage from the iron pipe. By thorough inspection and measurements at the end of two years, leakage on the wood pipe between Coyote and the Bonito Creek, from 11 in. and 12 in. pipe was found to be as follows:

On 8.6 miles of 11 in. pipe, 146,600 gal. leakage per day equals 17,046 gal. per mile. Four miles of 12. in. pipe, leaking 14,829 gal. per day, equals 3,702 gal. per mile. The 7½ in. pipe on this section, appears to be leaking less than the 12 in. pipe.

There is no material leakage from the 10 in. and 16 in. pipe between Bonito Creek and Nogal Reservoir, as determined by velocity and volumetric measurements hereafter described. The greatest probable error in the velocity measurements would not exceed ½ per cent. If such an error existed and was all charged to leakage, it would amount to but 17,204 gal. per day, or 1,582 gal. per mile, out of daily delivery of 3,784,000 gal. The measured discharge of the pipe as determined by the velocity was 5.84. sec. ft., while the mean maximum volume of water over the weir at the end of the pipe is recorded by the weir as 5.88 sec. ft.

From Coyote, east along the railway, the wood pipe is remarkably tight. The rate of leakage from it, as determined by 600 observations uniformly distributed, was as follows:

11-in. pipe equals 120 gal. per mile per day.
8½ and 7½-in. pipe equals 268 gal. per mile per day.

The observation was made by uncovering the pipe and measuring the leakage for 10 minutes. A graduated glass measuring to drams was used. The rate of leakage varied from 5 drops to 45 oz. in 10 minutes. Of the joints uncovered, 57 per cent were found to be leaking. It is rather remarkable that, in the large leakage in the 11 and 12 in. pipe between Coyote and Bonito only one out of every eight joints was leaking, indicating a physical defect in such joints. The largest leak found on one joint was at the rate of 17,280 gallons per day. Leakage between or through the staves is not measurable. The significant leakage of 120 gallons stated above is from the 11 in. pipe in the pumping main between Coyote and Corona. The present maximum pressure on it is 100 lbs. per sq. in. All the figures given above include visible or invisible leakage, the latter being such as does not appear on the surface. The visible leakage is but a small part of the total.

Cost of Pipe Laying:—Between Bonito and the railway, one gang of ten men could lay 4,000 ft. per day, though the average was much less, owing to a variety of causes. At the end, the railway company added to the contractors' force, and laid the last ten miles of pipe in seven days, there being six separate gangs at work.

Along the railway, the day's record on wood pipe was 4,000 ft. of 11 in., 6,200 ft. of 7½ in. and 8,345 ft. of 3½ in. pipe laid by a gang of eight men after the pipe was distributed along the trench. These eight men, of whom five were Americans, laid 76 miles of pipe, and became expert, their operations becoming like clock work.

On the 12 in. iron pipe, the regular day's work was 96 joints or 1,152 ft. of pipe, laid and caulked. The record was 1,644 ft., while two gangs laid 101,300 lin. ft. in 60 days. These gangs consisted of one foreman, one in-

spector, eight caulkers, four yarners, one melter, one pourer, one helper, and ten men putting pipe into the trench.

The pipe from Bonito to the railway was laid by contract. The price was 18 cts. per lin. ft., laid and backed-filled from the Lake to Nogal reservoir, and 28 cts. from Nogal to Bonito, in addition 50 cents per ton per mile was paid for hauling pipe, and extra compensation for setting valves.

From Coyote, east along the railway, the work was done by the railway company under the direction of Mr. J. L. Campbell, chief engineer. The total cost of laying 384,300 ft. of wood pipe from 11 to 3½ in. in diameter was $18,156, or $0.0472 per foot divided as follows:

Ditching,	$ .0249
Laying,	.0113
Backfilling,	.0110
Total,	$ .0472

This includes unloading from cars. Train service costs one-third cent per foot additional.

The pipe gang including back-filling, consisted of one foreman at $100 per month, one assistant foreman at $75 per month and about 30 Mexicans at $1 per day. The rates were the same in the ditching gang. The plow team cost $6 per day. Including all general expenses, the cost does not exceed $.06 per lin. ft.

The cost of laying 101,300 ft. of 12 in. cast iron pipe was $23,826, or $.235 per foot, divided as follows:

Ditching	$ .0249
Laying,	.1180
Backfilling,	.0110
Lead,	.0790
Oakum,	.0014
	$ .2343

This includes train service and unloading pipe, but nothing for tools. The foreman and inspector received $100 per month, the caulkers $3 per day, the pourers $3, the melters $2.50, two pipe men $2, and laborers at $1 per day. This work is standing perfectly under 275 lbs. pressure.

The cost of the pumping plants complete per horse power is as follows:

Pumps,	$79.00
Boilers,	18.70
Building,	41.70
Total,	$139.40

The approximate cost of storage capacity is as follows:

Nogal store reservoir,	$ 103.00
Carrizozo service reservoir,	3,040.00
Coyote service reservoir,	2,880.00
Luna reservoir,	3,480.00
Corona reservoir,	2,720.00

To cover general expenses, three per cent should be added to all costs above given. The cost per foot of pipe laying includes the setting of all specials, valves and stand pipes. The total cost of the pumping stations is $167,292.

The difference in cost in laying 11 in. and 3½ in. wood pipe is not nearly so great as the difference in diameter or the total quantity laid on record days. While the records are 4,000 ft. and 8,345 ft., the 76 miles of pipe of all diameters were laid in a total time, including all delays of 223

days or an average of 1,723 ft. per day. The cost of the 11 in. pipe is covered by $.07 per foot. The pipe was laid by a single gang as fast as it was received from the factory.

In caring for wooden pipe lines, the utmost care should be taken to keep the line full of water all the time, as that is one of the most important things in the preservation of wooden lines. In maintaining an even pressure on the line, gate valves should be placed in the line, to regulate the flow of the water, when the line is not carrying its full capacity to prevent it from drying out, thus causing it to leak and decay. In order to do this, automatic air valves were placed on high points to allow the air to escape so that the line may properly be filled with water, by closing down on the gate valves to fill the line with water. In all low places, mud valves were inserted for the purpose of washing out the line, when sediment has accumulated sufficiently to make it necessary.

To prevent bursting the pipe, relief valves or standpipes were provided so that excessive pressure will release automatically and overflow the standpipe, should any obstruction occur in the line. This has proved a satisfactory arrangement as no bursts have resulted from obstructions but the standpipes and relief valves have frequently overflowed, indicating that there was some such obstruction. By applying a gage along the line one could tell just what pressure was carried. One could also estimate the amount of water being delivered. Later, weirs were placed at the pumping reservoirs so that the amount of water delivered was checked as it flowed into each reservoir and it was possible also to check against the pumps, showing any deficiency that took place from slippage of the pumps or from leakage in the valves.

THE INTAKE:—It should be so arranged that there are apartments for settling the silt and sand before it enters the head of the line. The water must be drawn from near the top of the intake to prevent the drawing of silt and sand and it should be built to allow flushing and cleaning when necessary. When the water is first turned into the wooden line it is a good plan to place a large quantity of wheat bran in the head of the line as this settles in small cracks and forms a paste which stops a number of small leaks. It coats the pipe and does not injure the water. About one sack to each mile of 10 in. pipe is advisable.

MAINTENANCE OF THE LINE:—A close estimate has proven that the cost of maintenance is $.25 per mile per day or $.05 per 1,000 gallons delivered, in its full capacity. All water delivered from this line to tanks is controlled by automatic valves and requires very little attention.

Where the water is taken out the line is reduced to carry the same pressure below the delivery, which accounts for the different sizes of the pipe used in the construction of this line.

REPAIRS:—Wooden pipe can often be repaired by placing bands around the pipe with lugs and nuts. These are adjustable and can be drawn up to prevent leakage between the staves. When small leaks appear, in joints or defective pipe, they can readily be repaired by using soft wood as wedges and caulking them. It is much easier to repair breaks in the wooden line than in the iron, should any occur, for in the iron line it is absolutely necessary to take out broken joints and replace them with new pipe which is expensive, as each joint must be melted and the new pipe releaded. One can often repair broken cast iron pipe with bands, but it is not so satisfactory. The wooden line can be repaired without draining the line.

In rough country away from the railway, as some of this line is located, it would have been almost impossible to have used an iron line, owing to the cost of delivering the pipe along the trench, as a great deal of the pipe here had to be handled by hand. Consequently, a wooden line is preferable to iron in rough country as it can be replaced for less than the interest on the cost of an iron line.

RESERVOIR CONSTRUCTION:—There are four 2,500,000 gallon concrete reservoirs and one natural reservoir on this line. Two of these were con-

structed without being reinforced and gave way, causing considerable trouble. The other two were reinforced with ⅜ in. rods, spaced 12 in., center to center, throughout, and lapped 30 diameters. These reservoirs are 100 ft. x 200ft. in size and 16 ft. deep. They are covered with cement 4 in. thick, with a core of 18 in. of concrete used around the edge of the bottom and sides to prevent any settling. Soap and alum were applied to the cement as water proofing. The surfaces were afterwards heavily coated with asphalt and Elaterite paint to fill any cracks that might develop in the concrete, and this has proved effective. Great care was used to tamp all soft ground solid before putting in the concrete to avoid any breaks from the earth settling under the concrete. These tanks are constructed on a slope of 1½:1, with the coping 6 in.x18 in. around the top to prevent water from running underneath the concrete. The ground was sloped from the coping and well tamped to make the drainage perfect away from the concrete.

WATER STATIONS ON THE WESTERN AUSTRALIA GOVERNMENT RAILWAYS.

E. S. Hume, chief mechanical engineer:—Water supply for railway purposes is a question of first importance to officers in administrative charge of the railway system of this state. The long dry summers make it very difficult to provide a sufficient supply for all wants at inland depots, and the quality of the waters obtainable in many districts is very detrimental to the locomotive boilers. The sources of supply are of many kinds—natural rainfall catchments conserved in large dams or tanks, wells, lakes, river pools, and the Goldfields water supply main.

When a dam is constructed in a clay soil it is unlined, but where the soil is porous a cement or asphalt lining is applied. At Menzies, a Goldfields center, a dam of 7,371,000 gal. capacity is lined with cement, and also covered over with galvanized iron to reduce evaporation, which was found to be equal to seven ft. during the summer months. Great care is taken to prevent the catchment areas from becoming polluted, the land being reserved and cleared for the purpose. In some instances, particulars of the more important of which are given hereafter, the water is pumped through lengthy pipe lines to overhead receiving tanks, generally of 25,000-gal. capacity. These tanks are of cast iron, carried on staging, the staging being either a wooden or steel structure as found most convenient in the circumstances. The pipe lines are usually of cast iron three to six in. in diameter, with the ordinary spigot and faucet lead joints. These are cleaned periodically by passing brushes made specially for the purpose through the entire length of the pipe line. These brushes are of wire, similar to those generally used for cleaning boiler tubes, and several of varying diameters are mounted on a rod at the back of which a stout leather washer is placed, which acts as the driver when water pressure is applied. Engines take their supplies from water columns connected to the cast iron overhead tanks by 6 in. cast iron piping. Worthington double-acting pumps are in general use in connection with these supplies, and floating foot valves are provided in each case on the suction pipe to prevent any solid matter getting into the pipes.

In many districts the waters are of such a nature that serious damage to boilers would result from their use. The attached analyses are examples of such waters. By distillation, treatment with caustic soda, carbonate of soda, caustic lime, filtration and other means, each adapted to the particular water in question, the feed waters are kept fit for their purpose, but great watchfulness and care is necessary at all times in this regard. A few plants have been installed to automatically deal with waters naturally unsuitable, these including Mirlees-Watson "Yar Yan" distillers, and Kennicott and Archbutt-Deeley softeners, but generally waters are treated by means of locally-built measuring vessels placed on top of the overhead storage tanks, which automatically introduce the re-agent into the delivery from the main. The analyses on the accompanying table give a typical instance of water before and after treatment by this latter method.

WATER ANALYSIS.

WESTERN AUSTRALIA GOVERNMENT RAILWAYS. LOCOMOTIVE TESTING DEPARTMENT.

SAMPLE.	Alkaline Chlorides.	Alkaline Sulphates.	Alkaline Carbonate.	Alkaline Hydrate.	Magnesium Chloride.	Magnesium Sulphate.	Magnesium Carbonate.	Calcium Chloride.	Calcium Sulphate.	Calcium Carbonate.	Iron Oxide & Alumina.	Silica.	Organic Matter.	Oil.	Total Solids Grains per Gallon.	Hardness in Degrees Total	Hardness in Degrees Temporary.	Remarks.
Mundaring Water, (G.W.S.)	13.3				2.98		.14		trace	1.25	.14	.28	trace		21.0	4.5	1.4	Waters known to have caused considerable corrosion of pipes.
Do.	26.76				4.97		.15		1.94	.48	.33	.28	"		34.9	7.32	.7	
Victoria Reservoir, (Perth)	14.0				1.33		.92		.91	.33	.07	.49	"		21.0	4.1	1.4	
Chidlow's Well,	25.9				5.03		.20		1.85	11	.15	.15	"		33.4	7.1	.4	Do.
Karalee Dam Water,	1.73						.11		.6	.62	.14	4.48			7.68	1.0	6.2	Waters which have not caused corrosion of pipes.
Malcolm Dam Water,	4.8		trace				1.42			2.0	.07	.07	2.14		10.5	3.7	3.7	
Victoria Reservoir. Treated	15.4	94	"				1.47			1.17	.14	.14			20.3	2.64	2.64	Treated for use in boilers to prevent corrosion. Soda used.
Do. Untreated	14.0				1.33		.92		.91	.33	.07	.49	trace		21.0	4.1	1.4	
Mundaring Water, Treated.	18.4		2.6												27.0	2.6	2.6	
Do Untreated	15.6				2.66		.73		1.31	.55	.21	.35	"		26.0	5.2	1.4	
Lake Matilda Water,	11.1		2.03				2.49			1.92	3.84	.4	2-4		25.2	4.9	4.9	

E. S. Hume. C.A.L.

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Water Analysis, Accompanying Report of E. S. Hume, Western Australia Government Railways.

The following are a few of the more important boiler feed water pipe lines installed in this state:

Mount Malcolm is situated about 140 miles from Kalgoorlie, the chief Goldfields center, the latter being distant 375 miles from the seaboard and capital city. Water is stored in a dam estimated to contain 100,000,000 gal. when full, sufficient for a two years' supply without replenishment. A 10in.x10in. Worthington pump with a 6 in. diameter water end is utilized to force water through a 5 in. cast iron S. and F. main 7 miles long, laid underground the entire distance, and delivering into a 25,000 gal. standard overhead tank at a rate of 6,000 gal. per hour. At present it is only necessary to pump every second day to keep pace with requirements. The water is of excellent quality and the plant has been in operation for seven years without any maintenance cost.

Chidlow's Well is a wayside station situated 29 miles from Perth on the main Goldfields line, and is the principal watering depot outside of the metropolitan area. A dam formed in a valley by means of a weir, and holding 117,000,000 gal. is 1¾ miles distant from the station yard, and the connection is by a 5 in. cast iron S. and F. pipe delivering into two 25,000 gal. overhead tanks. A Worthington 12"x12" pump with a water end 7 in. in diameter and a 6 in. suction pipe, delivering 12,000 gal. per hour against a 190 ft. head. This plant has been in use for 12 years, and about 18 months ago its efficiency had become reduced by 3,500 gal. per hour owing to incrustation in the pipes, and the pressure to be overcome by the pump had been increased by 40 lbs. The consumption of fuel had also increased, but after the pipes had been cleaned by means of the brushes previously referred to, the plant regained practically its original efficiency. The delivery is again becoming restricted, showing that it is advisable to clean the pipes about every 18 months. The water in this dam contains corrosive constituents, and requires to be consistently treated, as will be seen by reference to the attached analysis. It is noteworthy that on the watershed at this place where trees, mostly gum trees, are growing, the water flowing into the dam contains only 4 to 6 grains of salt per gallon, whereas where the timber has been killed the salt contents are as high as 240 grains. Drains have been carried through such parts of the catchment area as are high in salt, and trees of a serviceable nature, such as may be used in the construction of cars or wagons, or fruit cases, etc., are being planted to absorb the natural salt from the soil.

Lake Matilda is situated 285 miles from Perth on the Great Southern railway, and is a large natural storage of water estimated at 200,000,000 gal. A Worthington pump 7½"x5", with a 6 in. water end pumps through 1½ miles of 4 in. galvanized iron pipe into an overhead tank of 25,000 gal. capacity. This overhead tank is constructed very cheaply, being of thin galvanized iron of circular form, flat bottom, and sweated joints. It is generally known here as a "squatter's tank," and is the latest introduction to reduce cost on sheep or cattle runs, or ranches. This supply has only been tapped within the last three months, but the water is very free from deleterious constituents, and the cost for maintenance should be very low.

Karalee, situated about 280 miles from Perth on the main Goldfields line, is supplied with water from an underground tank of 10,000,000 gal. capacity. A 6"x4"x6" Worthington pump operates through 2¼ miles of 3 in. cast iron pipe, against a 120 ft. head, delivering into a standard overhead tank at the rate of 2,500 gal. per hour. The catchment in this case is principally rock granite, and the water is collected into cement drains or stone gutters to the storage tank. The water is practically pure.

To furnish Goldfields, about 375 miles from Perth, with a plentiful supply of good water, the Government of Western Australia built what is known as the Coolgardie Goldfields water supply scheme. The scheme in the first instance comprised a pipe line of 30 in. internal diameter, 351½ miles long, with suitable impounding and service reservoirs. The source of supply is the Helena river in the Darling ranges, where a reservoir 760 acres in extent, with a capacity of 4,600,000,000 gal., and a catchment area of 569 square miles, was formed about 18 miles from Perth by the construc-

tion of a concrete weir 100 ft. high and 755 ft. long. The main is of the locking bar type, constructed of 1/4 in. steel plate for pressures not exceeding 390 ft. head, and 5-16 in. for greater pressures. Eight service reservoirs were constructed of 1,000,000 gal. capacity, at each of which a pumping station is located. The water is pumped from the main reservoir through each service reservoir, until it is finally delivered into a main service tank of 12,000,000 gal. capacity, situated 307½ miles from the Helena reservoir, and 1,290 ft. above the original intake. From thence the water flows by gravity to Kalgoorlie, an additional 44 miles. The pumps were capable of delivering 5,600,000 gal. per day of 24 hours, and the friction head was found to be 2.85 ft. per mile, delivering that amount. Work was started in connection with the scheme in 1898, and water flowed into Kalgoorlie in January, 1903.

The pipes were thoroughly and carefully coated with a mixture of coal tar and Trinidad asphaltum before laying, but in 1905 signs of corrosion became apparent, and leakages took place through pit-holes in the pipes in June of that year. It was observed later that the friction head was increasing in certain sections, and on opening up in these sections it was found that serious corrosion was taking place. Many attempts were made to combat this deterioration by cleaning and re-coating the pipes, but these were not satisfactory. The water was now being used extensively in locomotive boilers, and without treatment the boilers were being seriously injured by corrosion. The composition of the water at that time was as given in the accompanying table. Steps were taken to treat the feed water by a re-agent to neutralize the effect of the corrosive elements. The treatment by caustic soda, and lime in others, was quite successful when regularly and systematically applied, and the writer suggested to the administration in August, 1908, that lime treatment in the Goldfields main would probably result in an equally beneficial effect. After consideration, the matter was finally referred to an English board of experts, who recommended that measures be taken to prevent air from entering the main throughout its length; that a balancing reservoir be provided to cope with the seasonable fluctuations of demand; that an apparatus be established near the Helena reservoir to de-aerate the water entering the main, and that 3 grains of lime per gallon be added to the water. These recommendations were very fully considered, and an advisory board, of which I was a member, recommended to the Government that lime treatment only should be tried in the first instance, in view of the good results obtained by this means in several smaller pipe lines. This recommendation was approved and is being carried out, so far with good results, but no final conclusion has been arrived at.

As an indication of the benefit of lime treatment, a 6 in. Mannesman pipe line 12 miles in length which conveyed the above water from Kalgoorlie to Kanowna, and which after two years' service commenced to exhibit internal perforations until these perforations reached 18 per month, was so treated. On the introduction of lime the perforations fell to an average of five per month, from that to two per month, and during the last eight weeks of observation no perforations took place. This result was achieved 10 months after the first initiation of lime treatment on the 12-mile section.

Returning to the general practice for pipe lines in railway supplies in this state: Where piping required for suction or delivery pipes is less than 3 in. inside diameter wrought iron or steel pipe is used with ordinary screw ends screwed into ordinary tap couplings, flanges being used where the pipe is attached to pumps.

SPECIFICATIONS FOR A STANDARD WOOD PIPE LINE DESIGNED FOR A PRESSURE OF 80 POUNDS.

CHARACTER:—This pipe shall be machine made spiral banded wood stave pipe.

STAVES:—The staves shall be made of live, clear, straight grained and sound pine, fir, cypress, cedar or redwood, thoroughly seasoned, out of wind

and free of knots, checks, shakes, pitch pockets or streaks and worm, insect or bird eaten or bored wood. They shall be accurately milled and planed to perfect line and surface on all sides and edges and shall have a finished thickness of 1¼ in. The interior and exterior faces of the staves shall be finished to true circles concentric with the longitudinal center axis of the pipe. The edges of staves shall be cut on lines radial from the center of the pipe. A semicircular or V-shaped groove about ⅛ in. wide and deep shall be cut longitudinally the full length of the stave on the midline of one edge. On the other edge, a bead of corresponding location, size and shape to completely fill the groove shall be cut.

BANDS:—The pipe bands shall be round and they shall be made of pure iron containing of

Sulphur, not more than .020 per cent
Carbon, not more than .020 per cent
Phosphorus, not more than .005 per cent
Manganese, not more than .000 per cent
Silicon, not more than .000 per cent

When drawn, these bands shall have a tensile strength not less than 48,000 lbs. per sq. in.; an elastic limit not less than 32,000 lbs. per sq. in.; an elongation not less than 35 per cent; and a ductility that will permit the bands to be spliced by twisting into standard telegraph wire splices without sign of fracture in the metal which shall be homogeneous in composition, structure, ductility and strength.

STAPLES AND LUGS:—All staples and lugs used to fasten the bands on the pipe shall be made of the quality of iron above specified for bands.

GAGE:—Five sizes of bands shall be used as follows:

No. 1, Diam. .285 inch
No. 2, Diam. .265 inch
No. 3, Diam. .245 inch
No. 4, Diam. .225 inch
No. 5. Diam. .205 inch

Staples shall be 1 in. long and shall be made of No. 8 wire.

Lugs shall be made of 3-16 in. iron with two spikes on the bottom 1 in. long and two side ears projecting 3-4 in. above the seat. The width of the lug seat shall be equal to three diameters of the band. The point of the staples and spikes shall be turned to cut across the grain of the wood to avoid splitting the staves. Lugs shall be cut and stamped to required form.

GALVANIZING:—All bands, staples and lugs shall be galvanized by pure zinc thoroughly applied in a uniform and adhesive coat of a weight of two oz. per sq. ft. of covered surface. The iron shall be free of dirt, grease, rust, scale and all other foreign matter. Acids used in the cleaning and preparatory process shall be neutralized so as to prevent corrosion by them under the zinc. The entire process of galvanizing shall be faithfully and completely executed under the supervision of a chemist experienced in galvanizing.

If a galvanized sample shows removal of zinc or a copper colored deposit after four one-minute immersions in copper sulphate, each followed by washing in water, the lot of galvanized wire from which the sample was cut shall be rejected.

The copper sulphate solution shall consist of 34.5 parts of copper sulphate in 100 parts of water and it shall have a specific gravity of 1.185 at 70 deg. Fahr. When used for testing, the solution shall have a temperature between 60 deg. and 70 deg. Fahr.

WINDING:—The band shall be spirally wound with uniform pitch on the pipe from end to end, spigots excluded, by a winding machine and under

a tension great enough to slightly embed the band into the wood; to produce perfect contact between the band and the staves, and to draw the joints between all staves to a close and watertight contact throughout. Loose winding or deep crushing of the wood shall cause the rejection of pipe so wound.

The first two turns of the band shall lie against each other in planes perpendicular to the longitudinal axis of the pipe, the first turn being uniformly 3½ in. from the end of the pipe. The beginning of the third turn shall be the beginning of the spiral winding. The latter shall terminate in two parallel turns having the same relation and position to each other and to the terminal end of the pipe that the first two parallel turns have to the initial end of the pipe as above described.

The gage of the band and the pitch of the winding shall be as follows:

On 6	in. pipe,	gage No. 5,	pitch 1⅓	in. or	9 turns per lin. ft.
On 6¾	in. pipe,	gage No. 5,	pitch 1⅕	in. or	10 turns per lin. ft.
On 7½	in. pipe,	gage No. 4,	pitch 1⅓	in. or	9 turns per lin. ft.
On 8½	in. pipe,	gage No. 4,	pitch 1⅕	in. or	10 turns per lin. ft.
On 9	in. pipe,	gage No. 3,	pitch 1⅓	in. or	9 turns per lin. ft.
On 10½	in. pipe,	gage No. 2,	pitch 1⅓	in. or	9 turns per lin. ft.
On 12	in. pipe,	gage No. 1,	pitch 1⅓	in. or	9 turns per lin. ft.

FASTENINGS:—The initial end of the band shall be bent short 90 deg., the end being long enough to lap under the first three turns of the winding. The end shall be hammered down to a full bed in the wood and be held by two staples.

The terminal end of the winding shall be held by a lug. The latter shall be driven down and seated on the stave where the spiral winding terminates. The band shall pass three times over the seat of the lug. The ears of the latter shall be bent back and be hammered down over the ears of the lug and be held by a staple. The parallel winding at each end shall also be held by staples driven at points diametrically opposite the fastenings above described.

SPLICES:—The banding shall be in lengths as long as are obtainable and practicable. When splices are unavoidable, they shall be the standard twisted telegraph wire splices, or equivalent, developing 100 per cent of the strength of the band.

JOINTS:—Joints in the pipe shall be made by driving the turned spigot ends of the pipe into cast iron sleeves.

SPIGOTS:—Three inches of each end of each section of pipe shall be accurately turned on the exterior diameter of the staves to a true circle and a perfect surface having a diameter throughout two in. greater than the nominal diameter of the pipe, thereby making the spigot one in. thick with a shoulder at the base uniformly ¼ in. high all around. Both edges of the end of each spigot shall be chamfered $\frac{3}{16}$ in.

The exterior diameters of spigots shall be precisely as follows:

On 6	in. Pipe	8 in.
On 6¾	in. Pipe	8¾ in.
On 7½	in. Pipe	9½ in.
On 8½	in. Pipe	10½ in.
On 9	in. Pipe	11 in.
On 10½	in. Pipe	12½ in.
On 12	in. Pipe	14 in.

To maintain proper relation to the internal diameters of the cast iron sleeves, no variation from the above dimensions shall be allowed.

CAST IRON SLEEVES:—The cast iron sleeves shall be made from first class gray iron. Test bars one in. thick, two in. wide and 26 in. long shall be cast as required, and, when laid flatwise on supports 24 in. in the clear,

each bar shall break under a concentrated center load of not less than 1800 lbs., and shall show a deflection not less than .30 in. before breaking.

All sleeves shall be uniformly sound and shall have clean, true and smooth surfaces. They shall be cleaned of burrs and foreign matter.

Each sleeve shall be six in. long with a shell ½ in. thick. The inside edges of the ends of the sleeves shall be rounded on a radius of ⅛ in. The entire interior surfaces shall conform throughout exactly to true circles having the following diameters:

For 6 in. pipe, the interior diameter of sleeve shall be 7⅞ in.
For 6¾ in. pipe, the interior diameter of sleeve shall be 8⅝ in.
For 7½ in. pipe, the interior diameter of sleeve shall be 9⅜ in.
For 8½ in. pipe, the interior diameter of sleeve shall be 10⅜ in.
For 9 in. pipe, the interior diameter of sleeve shall be 10⅞ in.
For 10½ in. pipe, the interior diameter of sleeve shall be 12⅜ in.
For 12 in. pipe, the interior diameter of sleeve shall be 13⅞ in.

A variation of 3-64 in. from the interior diameters above specified shall cause the rejection of the sleeve. Each sleeve shall be checked by a template for correctness and uniformity of interior diameter.

LENGTHS:—The minimum length of any pipe sections shall be not less than eight ft. The average length of all sections shall be not less than 12 ft.

COATING:—All pipe and all cast iron sleeves shall be coated by refined asphalt or coal tar. The pipe shall be turned on asphalt rolls until it has taken all the coating that it will carry, spigots excepted. It shall then be rolled on a saw dust table until the coating has become covered with a solid covering of saw dust. The flow point and the temperature of the asphalt or tar shall be regulated to secure a heavy, uniform and tenacious covering which, when hardened, will not flow under prevailing temperatures during manufacture and shipment. The spigots and the interior of the pipe shall be kept free of this coating.

B. J. MUSTAIN,
E. S. HUME,
D. BURKE,
E. R. FLOREN,
W. C. DALE,
Committee.

DISCUSSION

The President:—We will be very glad to have a discussion of this subject by any member. This is one of the problems that a great many railroads have to deal with and the water supply is a very important matter to them.

Mr. Knowles:—We have no pipe lines over four or five miles long. I am interested in the discussion of the wood stave pipe, because our experience with this is exactly opposite that outlined in the report. I have a line of wood stave pipe about three and one-half miles long on which I think I have spent about $800 in repairs. Much of the data on wood stave pipes has been collected on pipe which our forefathers made when they used the entire log. The log was bored out, turned off on the outside, wound spirally with bands and coated with pitch. In that way,

they removed the sap and the heart, and left only the best timber, but today we are using staves made from the entire log, sap, heart and good timber also. In making the wood stave pipe, we are also using a steel band where they used a wrought iron band and are coating it with so-called asphalt, often coal tar from which all the preservative has been removed. I notice also that the report states the pipes should be heated before the asphalt is applied. I do not understand how it would be possible to heat a wood stave pipe to a sufficient heat to make that application, unless in short sections. It reads as follows: "A satisfactory method is to dip the pipe in asphalt at the proper temperature, the pipe also being heated."

Mr. A. S. Markley:—I think that referred to iron pipe.

The Secretary:—As I understand it, the wood pipe is only heated sufficiently to receive this coating in the best way. It is not supposed to be made hot, but only heated so that this coat will take effect, and to insure that the pipe will not be so cold as to chill the asphalt before the wood becomes impregnated.

Mr. Knowles:—We have many members here from the West who probably have had a good deal of experience with wood stave pipe and I should like to hear what their experience has been. Mine has been bitter.

Mr. J. H. Markley:—When the water works were first built at El Paso, and Washington, Ill., wood pipe wrapped with wire and coated with asphalt was used. In six to ten years they had to commence taking it out and today it is all out. Personally I have not had much experience with wood pipes.

Mr. Knowles:—South Elmhurst, just outside of Chicago, also had a wood stave pipe line a number of years ago which has been removed.

The President:—We would like to hear more about these different classes of pipe lines, especially from the western people; I am sure they have had experience in this line of work.

Mr. A. H. King:—We are now laying some wood pipe line, and we have laid some with pretty good results, but none has been laid long enough for us to have had any failure. The rule that I would follow in recommending its use would be to lay it in places where it was generally moist,—where the wood can be kept wet on the outside of the pipe. What little experience I have had with it would indicate that if laid on dry ground, it will rot out in a few years. If submerged in water or in wet ground, I think

it would, perhaps, be preferable on account of chemical decomposition that might affect iron pipes.

Mr. Knowles:—I don't want to say everything bad against the wood pipe, because I know of some cases, Valparaiso, Indiana, for instance, where the city has had a 12-in. pipe line in use for 20 years. That, however, was made from solid logs and it has worked out very satisfactorily. My objection is that we are not getting the quality of wood we got in the old days but we are getting a different kind of pipe. There are doubtless places where we have a uniform pressure and soil conditions are right, where it would be advisable to use wood because it is 25 to 40 per cent cheaper in first cost and about as much cheaper to install.

Mr. J. J. Taylor:—We have two wood stave pipe discharge lines of about two or three miles each which have been in service about three or four years. I am sorry to say that this pipe has proven very unsatisfactory. The cost of maintenance has been excessive. We have been unable to hold it together at the joints, and we have had several instances where it blew out through the staves. I cannot recommend the wood stave pipe and don't think it will compare at all with cast iron.

The President:—Under what pressure is this pipe used?

Mr. Taylor:—I would say the pressure was about 75 pounds and sometimes probably as high as 100 lbs. We do not have a very high pressure where we use it.

Mr. Knowles:—That is a point I didn't mention. On the particular pipe line I referred to I believe this is largely responsible for the condition of the pipe. We have a static pressure from the city mains and city stand pipe of 40 lbs., but in case of fire that pressure is increased to 95 or 100 lbs. That is what I believe causes the trouble with the wood stave pipe, because naturally there is an expansion and contraction of the staves that works it loose and allows the water to ooze in under the bands and the asphalt coating, leaving the bands bare. If these bands are made of steel, you can readily see what will happen as far as corrosion is concerned.

The President:—I saw a wooden pipe at the office of the city engineer in Jersey City which was made out of a log. I don't recall the year, but I dare say it was under the ground about 70 years and it was still in good condition.

Mr. Alexander:—We have had no such long pipe lines as have been spoken of here, or any wood pipes; but I presume this

subject is not confined altogether to wood or iron of any particular kind. We have perhaps 5,000 or 6,000 ft. of wrought iron pipe which had been dipped in asphalt originally, the pipe being heated before dipping, so that it was thoroughly coated both inside and out. It seemed to be necessary to hang this pipe line up under a wharf—it was for the water supply for vessels—so that it would be clear of the water but out of the way of the traffic above. Plugs descended at various places where we could attach and get water. The pressure was about 125 lbs. per sq. in. at that point. We found in five years that this pipe had corroded through the paint outside so one could stick a knife through it in places and it began to leak so that we had to tear it out. We found that pipe which was placed on top of the wharf lasted a great deal longer, so we renewed that pipe with wrought iron, boxed it and laid it along the front of the wharf, back of the timber, where it was covered so as not to be in the way of construction. We tried to get what was recommended as wrought iron. not steel.

We have found, in the ground where we have a great deal of so-called wrought iron pipe, that in some places it lasts indefinitely,—especially in wet ground. It has been said here that iron pipe lasts indefinitely in wet ground while it will rust out largely in dry ground. This is what we found underneath the wharf. Where the spray continually kept at the pipe it would rust out and scales would form a quarter of an inch thick. While these scales adhered to the pipe, the iron would waste away until the pipe was eaten through; we find that both in pipe lines and tank hoops, there is a great difference between metals. With us some tank hoops last for 25 years and are still good, while others give way and fall off the tank in six years. It must be the difference in the metal, for there is no difference in the climate.

Mr. Staten:—On the C. & O. we had an old wood pipe line that was made by hand. We cut down the saplings and bored a three-inch hole with an auger which was fitted into a wooden handle, two men doing the work. The bark was not even removed from the poles. The hole was enlarged a little in one end so as to receive the end of another which was tapered down with a drawing-knife. The length of this line was about 5,000 ft. I do not know how long it was in use, but it was there a long time. Only a short time ago I saw a piece of it that had been unearthed in putting in a pit.

Mr. A. S. Markley:—That was a gravity line, was it not?

Mr. Staten:—Yes, a gravity line off the Alleghany mountains, I will ask Mr. Vandegrift if he can tell us how long that wood pipe was in there.

Mr. Vandegrift:—It was there 25 or 30 years. The sections were cut in 10 ft. to 16 ft. lengths. Some were so crooked they had to be bored from both ends.

Mr. A. S. Markley:—Is that pipe line still in service?

Mr. Staten:—No, the tank was removed for the reason that there was not sufficient water to supply the demand, and when the tank was removed the pipe line was abandoned.

Mr. Ewart:—We have a few long cast iron and wrought iron pipe lines on the Boston & Maine. There is one trouble we have which I have not heard spoken of here; I do not suppose that it causes much trouble in the country, but we are bothered a great deal with electrolysis on our cast iron lines. A leak was reported to me the other day. I sent the men there to dig it up, and to repair it, and they found, when they got down to the pipe, that they could whittle it with a knife. It wouldn't hold any pressure. If struck in one place the pipe would break off and on the other hand, in other places it was all right. I laid that pipe line myself about 25 years ago. Electrolysis is the great trouble in the neighborhood of Boston. All the city water lines have the same trouble. Four years ago I renewed a line replacing about 4,000 feet of eight-inch and six-inch pipe with twelve-inch. The pipe I took out was eaten all the way through by electrolysis. Until one gets at it, he can not tell anything about it. It may look all right, but it may go to pieces. It seems to be eaten away as though something had been wearing on it. Nobody has yet found any way to overcome it, and I believe it limits the life of our cast iron lines. We have a lot of wrought iron pipe, and in ordering we always specify genuine wrought iron pipe. This costs us considerably more than steel pipe, but it pays to put it in. We have places where we can put steel pipe in the ground and almost see it disappear. It will not last. I have taken steel pipe out that had not been in a year. I think wrought iron is preferable on the ground of economy. We have thousands of feet that are laid out in the open. When we lay it on a bridge, as Mr. Alexander has spoken of, my plan is to lay it in a hard pine box constructed of two-in. material. We are laying a three-inch pipe for water supply. We put it in a two-inch hard pine

box about 12 inches square, centering the pipe as nearly as possible in the box, filling the box with "spent" tan bark and then making it as tight as possible on top. That construction will withstand a considerable amount of freezing and I think it has a tendency to preserve the pipe. We find that galvanized iron pipe (although that is poor enough) will stand better than the common iron. We never have used asphalt or tar. We either use the plain or galvanized pipe, but no matter what we put in, we have troubles enough. I suppose the elimination of danger from electrolysis would be one thing in favor of the wood pipe. Electrolysis would never hurt that, but we never have had any of it.

Mr. Staten:—There is a big foundry at Lynchburg, Va., that makes iron pipe of all sizes. The city of Lynchburg gets its water supply about 16 miles away, and the wood pipe for this was shipped from California. I have seen four or five car loads of that pipe on the side track there, and on another side track as many more cars of cast iron pipe billed to California. There must be a good reason for shipping this iron pipe to a country where they manufacture wood pipe or else their wood pipe does not give satisfaction in that country.

Mr. Killam:—We have no very long pipe lines on the Intercolonial Railway, the longest being probably four miles. We have always laid cast iron pipe with the joints caulked with lead, and for the last 13 years or more, we have never known a pipe to give out. Our pipe lines are all of cast iron pipe with lead joints, or wood backed up with lead, and put down below the surface. In some places, where necessary, they come to the top, but they have never given out. At one time I built a line of railway 45 miles long where we had short pipe lines except in one place, the longest one consisting of 4,000 ft. of wooden pipe line. I used 10-ft. sections of timber, not less than 8 in. through at the top, and the bark was all left on, taking the timber in its natural state as it came out of the woods. It was all fitted together with a machine that drove one section into the other. Each joint was saturated with Stockholm or American tar and the big end of the tree was banded with Swedish iron. This pipe line stood until we abandoned the tank system at that place 12 years later and we never had a leak. In making the pipe, we ran a piece of hot iron through each joint to do away with the friction. It was also claimed at that time that searing the inside of the wood acted as

a preservative, taking the sap out of it. It withstood a pressure of about 35 ft. head from the spring to where it came into the tank.

Mr. Robinson:—In 1893 we laid two miles of cast iron pipe in our shop grounds at Chicago and covered it with sand and cinders. In 1899 we found it completely gone, took it out and laid about five miles of 6-in. to 12-in. pipe, covering it with blue clay. Up to the present time it is perfectly preserved.

Mr. Warcup:—I agree with Mr. Robinson in regard to keeping cinders away from the pipe. It is necessary to have a protection of clay or sand to keep the cinders away, or the pipe will rust through. Also, in regard to electricity in water-mains, an incident happened not very long ago, at a standpipe at Chatham; the street car line is about 200 ft. from the standpipe, and we couldn't find out why this pipe was electrified, but finally discovered that the rails of the street car track were connected by a ground wire to the pipe so that when a man was on the tender taking water, he got a shock. Also, in another instance some telegraph batteries were attached to a wrought iron pipe, and that pipe was completely pitted on the top. On the Grand Trunk we use principally galvanized iron pipe for small pipe from 2½ in. down to ¾ of an inch; above that size we use cast iron.

Mr. Knowles:—I am glad to hear this discussion of the protection of pipe lines, because I think that it is a very important subject and is something I have had to contend with. One gentleman spoke in regard to lines laid along the wharf. I had a similar experience with 6-in. wrought iron pipe with 4-in. risers, laid along our Stuyvesant docks at New Orleans. We found it necessary to renew that pipe line, in fact we are renewing it now, after a service of five to six years. That pipe was dipped in something supposed to be asphalt, and we found it corroded rapidly. We are now putting a wrought iron pipe in on the other side of the wharf and we have an analysis made of a section of this pipe to see that it does comply with the requirements for wrought iron pipe.

I have also had some experience with electrolysis at Paducah, Ky. There is no doubt that much of our electrolysis is caused from ground wires attached to the pipes, but there is a great deal also coming from places where the pipe line lies between two power transmission lines. This is going to get more serious every day as power transmission lines increase in number. In this instance we had a street railway line on the west and a

mechanical coal chute on the east with a high power transmission line to the chute and a 6-in. line, perhaps 600 ft. long, between the two. The current seemed to jump from the street car line and follow the 6-in. pipe line to the coal chute, where it would leave the pipe, leaving a hole, as Mr. Ewart says. I do not know that there is any method for preventing electrolysis; if there is, I never heard of it. It might be possible for us to connect up on the other end and transmit power, too, but I don't think the power companies would stand for that.

Mr. Warcup:—Electrolysis is more serious than most of us are willing to admit. We have a number of miles of Pintsch gas pipe lines, on which we had occasion a while ago to make some repairs. The gas was drawn back and as soon as we broke the joint the thing instantly took fire. It frightened the men working on it and they did not know what to make of it, but it was caused by the electricity running down the pipe, igniting the gas at the break in the pipe. This was on a bridge, and I suppose the electricity was running for the water which it would have reached if it had gone a little further. Now, when we have occasion to break a pipe on the bridge, we always wind a piece of copper wire on one side, then connect it on the other side and carry the electricity beyond us. That is the only way we can handle it.

We have also had our troubles with cinders so that now, in laying either cast iron or wrought iron pipe through cinders, we take the cinders out below the pipe and fill in with sand or gravel for a foot above the pipe before we let the cinders in. I have cases where we have lead services and we have been obliged to do the same thing, as they will eat a lead pipe out in two or three years.

Mr. Robinson:—Some kinds of sand are also injurious to cast iron pipe. We have a pipe line about three miles long that has broken in places and we found that pitting caused it. We never found any electrolysis on it, although there are several electric lines in the vicinity.

Mr. Alexander:—We have frost in our country that often goes to the depth of six feet. That is as low as we lay pipe and sometimes a small pipe will freeze. To protect it from the frost. I have often laid a V-shaped wooden box inverted over the pipe to keep the frost from striking it, leaving an air space along the pipe as it was filled. In some instances we make a square box

and case it in thoroughly. The question occurred to me whether boxing a pipe would keep the different materials away that would destroy the pipe in case of electrolysis. It might be a good suggestion to try this and fill the box with some material that would preserve the pipe and perhaps prevent electrolysis.

Mr. Clark:—The troubles with pipe lines appear to be local; I think every section of the country has its disadvantages. We have some disadvantages in Western Pennsylvania, that I have not heard anyone speak of. I refer to the effect of mine water on pipes. On my last inspection I found one 30-in. sewer pipe under the track which had been in only a very few years entirely eaten away by mine water. On some parts of the road, especially along the Allegheny River, the sand apparently eats the pipe out almost as quickly as cinders. We all know that the cinder is a deadly enemy of pipes, and in cinders, we either box the pipe, or else excavate and get clay, put down a bed of clay, lay the pipe in it and cover it over. We find that does very well. On some of our lines where we have interlocked switches operated by air, we have places where we carry the air from one to two miles. In such places we put the pipe line in a box and then fill the box entirely full with pitch and cover it up, practically hermetically sealing the pipe. The remedy for all these things must be found to suit the conditions. We all know that there are places where a tile pipe will outlast a cast iron pipe.

Mr. Dupree:—We all know that mine water contains sulphuric acid, which destroys pipes. One gentleman spoke about putting a little sand over the pipe, then cinders over the sand, which is wrong, because the acid from the cinders will penetrate that sand and attack the pipe. The best way to prevent this is to put a covering over the pipe as Mr. Robinson said, of blue clay or other material of that nature, wrap the pipe with some kind of mineral roofing, then put cinders or other material at hand, over it, so as to shed any acids off the pipe.

Now, in regard to galvanized pipe; it usually is good, but the manufacturers sometimes make galvanized pipe of inferior quality, then cover it over, and the galvanizing preserves it. We should be cautious when we put galvanized pipe together for on the end where the threads are, ⅛ inch of the metal is gone, and the couplings should be made strong enough and long enough to cover all the metal that was galvanized and is cut

away. It is the same way with the black pipe. We should cover the couplings and protect the threads.

Mr. Knowles:—In covering an underground pipe, I am of the opinion that in some cases it would be necessary to spend as much and in many cases more, to get the proper covering as to put the pipe in, and if one puts a pipe under ground and the soil conditions are not right it is hard to protect it. Clay is all right but in many cases one is working in soil where he can find no clay. If one put sand around the pipe and cinders over the sand, as Mr. Dupree says, the sand is not much protection against cinders or mine water. It might act as a detriment because it might concentrate the action of the acid on the pipe and cause it to become more vigorous in its action. In regard to covering it, I do not think one can put on a satisfactory covering without its becoming more expensivve than the pipe itself. One would have to use tile or something of that sort, and he would have a dead air space around the pipe, but that would cost more than the pipe line. I think a covering is out of the question for an ordinary cast iron pipe line or any underground pipe. The best protection for a pipe line is either to lay wrought iron and be sure that you get wrought iron, or to lay a cast iron pipe and keep injurious filling from coming in contact with it.

Mr. A. S. Markley:—We have our troubles on the inside of the pipes as well as the outside; I would like to know if there is any remedy for that? Another thing our subject covers is tanks. We have our troubles there, too, with mud flowing into the well and filling it up.

Mr. J. H. Markley:—We have two large reservoirs where we take water from a suction pipe that runs into them. In both cases I have built wooden sumps made about 6 ft. square and always take the water down over those sumps. I have never had any occasion to clean them out and never have any trouble at all with them.

Mr. A. S. Markley:—That would apply to ponds, but we have streams where we can't do that; we've got to take water from the streams.

Mr. J. H. Markley:—We have a case of that kind also. We have a pipe running out into Spring river, which is about as muddy a stream as one will find, being fed mostly from prairie farms. The pipe leading out into the stream is an 8-in. pipe, and on the end I have placed a valve that is opened when the man

begins to pump, and is closed when he gets through. We have very little trouble with mud.

Mr. Knowles:—I think Mr. Markley's point is well taken. We ought to consider the inside of this pipe as well as the outside. We have many stations on the Western lines through Iowa where we have the same trouble with sand and silt coming down. We construct a wood or concrete sump depending on the material we have handy. If we have bridge timbers, we construct it of that material which answers very well with an intake in a river. We clean it out, but at certain places every year we have trouble with leaves and rubbish of that sort which is hard to get at, because it usually comes down during the flood period when one cannot get at his pipe line. In such cases we have had great success with multiple strainers. One can secure them in one, two, three or four chambers. Two are enough for ordinary conditions. They are located in the pump house next to the pump. The end of the pipe is left open and anything that will pass through the pipe is caught in the strainers. It is not necessary to stop the pump while the strainer is being cleaned as one side can be shut off while the other is being operated. We have them in our 26th Street station, Chicago, where we have trouble with rubbish and small minnows getting into the pipe. I have seen barrels of these minnows and stale hops from a nearby brewery get into the suction pipe. This is the most successful method of keeping the suction pipe clean. Of course, where one has a large amount of sand this would not do any good, as the sand will fill the suction pipe. Referring to incrustation inside of the pipe,—we have had some experience with that,—but it has not been from our treating plants. The Big Muddy pipe line is about four miles long, three miles of which is 8-in. cast iron pipe and one mile 12-in. That line was laid about 1903, and in 1908 the pressure went up until it was necessary to carry 140 lbs. to deliver a million gallons a day, which indicated that it was partly clogged up, so we had it cleaned.

Mr. A. S. Markley:—We make our intakes 300 to 400 ft. in length, or less where conditions will permit, through which the water flows by gravity from the stream into a well. The well answers the double purpose of reducing the temperature of the water in cold weather and permits the sediment to settle before the water enters the pumps. The intakes should be no larger than necessary to supply the pump; this causes sufficient cur-

rent to keep the passage clear of sediment. The well must be cleaned out occasionally to remove sediment which has collected.

We have 13 treating plants of both types,—intermittent and continuous, all of which use the same ingredients,—soda ash and lime. At our Oaklawn shops at Danville, Ill., we have the continuous process which was installed in 1905 or 1906. The power house is located some 450 ft. from the treating plant, which has a 3-in. supply pipe for the boilers and this has become so clogged with incrusting matter that we shall have to replace it and then we will take up the old pipe and try to clean it out. We have been informed that it is impractical to remove this incrusting matter while the line is in service. At our intermittent plants we experience trouble with inspirators and their connections in becoming clogged. Brass seems to collect incrusting matter more readily than iron.

Storm sewers at Oaklawn are being affected by reason of the sediment from the treating plants and it is getting to be a serious matter. The sediment is so hard that it is almost impossible to remove it with sharp pointed tools. If any of our members will inform me how to remove this sediment it will be appreciated.

Mr. Dupree:—I think I can answer Mr. Markley in regard to his treating plants, as I am slightly acquainted with them, since I built six of them myself. I built the Oaklawn plant and I know the conditions thoroughly. If Mr. Markley will allow the water to settle longer, clean out the tanks properly and not blow the sediment from the 80-ft. stand pipe into a sump, but draw the water off the top and haul away the sediment and not permit it to get into the sewers it will save all of that trouble. "An ounce of prevention is worth a pound of cure," and pipes, sewers and drains should receive careful attention where sediment is found.

Mr. A. S. Markley:—We try to be as careful as possible in that respect. At Oaklawn the sludge is run out through a surface sewer with no settling basin. At other places where we have intermittent plants we make use of settling basins, from which the sludge is hauled away by teams; but even with these precautions so much sludge and sediment gets into the ditches and drains as to cause criticism on the part of the authorities, and we have been refused the use of drainage ditches until the matter is remedied.

At our Oaklawn plant the treated water flows by gravity from the top of the 70-ft. treating reservoir into the storage tank,

but in this process it is not possible to remove more than 40 to 50 per cent of the sediment where such a large quantity of water is used.

Mr. Clark:—We aim to take the water from the downstream side, where we put an intake in a stream in order to allow sediment and rubbish to flow past as far as possible, so that no material will catch and flow in other than as the natural suction of the water carries it into the sump. In several instances we have a row of 4-in. or 6-in. pipes along the lower side, maybe 15 or 20 of them, to allow the water to flow in slowly, so as not to draw in any more sediment than can be avoided. Then, the floor of the sump or intake box is a certain distance below the intake pipe to give the sediment that has entered a chance to settle. It is then cleaned out, which necessarily must be done by hand. In regard to the softening plant: we make it our practice to change the excelsior and clean the tanks once every six months, as far as possible. We allow the sediment to settle and then clean the tank out thoroughly. We have a manhole on the side of the tank and the sediment is all thrown through that and disposed of; in that way none of it goes into the sewers. The matter of connecting to a sewer to save a little money came up some time ago, but was disallowed because of just what Mr. Markley is talking about,—liability to close up our sewer system. I don't think there is any way that one can prevent all matter from getting into the intake pipe or into the intake box, but the only thing is to fix it so that as little as possible will get in and then arrange so that what little does get in can be taken out by hand.

Mr. A. S. Markley:—We follow the plan suggested by Mr. Clark, of course, but we are continually pumping out of the well and the current in the well brings up the material. We have just finished a well 16 ft. in diameter, placing the bottom of it 4½ ft. below the stream and topping it with concrete, so we have no trouble in that direction, but we get mud in just the same.

Mr. Clark:—The idea of putting so many of these small pipes in is to allow the water to flow very freely into the intake box, so that neither the pumping out of it nor the force of the flowing in, will keep the sediment stirred up. The idea is to keep the water in there as quiet as possible, to allow more of the sediment to settle.

Mr. Knowles:—I don't think we will ever succeed in keep-

ing mud out of our intake boxes. The only think we can do is, as Mr. Clark said, to reduce it to a minimum and clean it out occasionally. The sand is in the water and as long as we continue to pump during flood stages we are going to get it. We might have a series of intake boxes and bring the water through three or four of them. In that way we could eliminate the sand, but the scheme is impracticable. I have tried it in a number of cases where the sand was coarse, but it would not do in a sandy loam. Where the sand was very coarse, I have used old, discarded well screens, 20 ft. long, putting them in a sandy bed of a river; they will work all right except where the water is very muddy, when the sand becomes impregnated with mud and the water will not go through. I have used this method successfully in a number of cases in the South.

Mr. Elliott:—We have one place where we supply a village with water suitable for domestic use and also supply our shops and locomotives. In digging the reservoir near the river we struck quicksand a little below the bed of the river and could not go much deeper. We went as low as we could, however, and put in a wooden box which came above the sand perhaps two or three feet and yet was below the surface of the water. We filled around outside of the reservoir with broken stone, and made a large intake which extended from the reservoir to the river which was below the water all the time and provided a sluggish flow to the filter. The foot valve is at the bottom of the box, and no sand can get to it. The sand does not rise above the top of the box but the water flows over it all right and in that way the sand is excluded from the foot valve.

SUBJECT No. 9.

DEVELOPMENT OF TURNTABLES TO MEET OPERATING CONDITIONS FOR THE MODERN LOCOMOTIVE, SHOWING THE BEST IMPROVED PRACTICE.

REPORT OF COMMITTEE.

Your committee takes pleasure in presenting a complete report. Under other conditions an apology for the length of the report might be in order, but in view of the length of the title assigned to the subject by the president, the length of the report appears justified. On account of its length, however, the committee did not feel justified in adding another chapter on the history of the subject.

A circular letter was prepared and sent to about 60 railroads with the expectation that perhaps one-half of that number would respond. After a month had elapsed tracers were sent out, and at the end of three months replies had been received from 57 roads, aggregating 175,000 miles of line. The information with reference to features in which practice varies widely was tabulated under the following eight headings:

Length of standard table.
Type of standard table.
Loading and unit stresses.
Locks for holding rails in line.
Power for turning.
Means to fasten rails to parapet and circle wall.
Approximate cost.
Centers.

The tabulation accompanies this report.

After the tabulation had been prepared the Committee held a meeting at the Missouri Athletic Club, St. Louis, Mo., June 25th, and spent the entire day in the study and discussion of the information at hand. At this meeting there were present C. E. Smith, Chairman, J. S. Berry, A. S. Markley and C. H. Fake. Mr. F. G. Jonah was absent.

The Committee concluded that the information furnished by the roads was unusually full and complete, and indicated tremendous interest in the subject all over the country. We feel deeply indebted to all the roads that took such unusual measures to respond fully, and especially desire to express our thanks to Mr. A. Montzheimer, chief engineer, Elgin, Joliet & Eastern, for his complete information on the subject and particularly for the information he furnishes relative to the so-called non-tipping tables; also to Mr. A. F. Robinson, bridge engineer, Atchison, Topeka and Santa Fe system, who furnished the Committee enough information to make a complete report on the subject.

The Committee's discussion of the subjects treated under the eight headings mentioned above, and of a number of other features that were discussed, together with a brief synopsis of the information secured and its recommendations where such were considered advisable, are given in the following pages.

Standard Length.

STATEMENT SHOWING STANDARD LENGTHS OF TURNTABLES USED BY VARIOUS ROADS.

75 ft.	80 ft.	85 ft.	90 ft.	100 ft.
B. & M.	B. & O.	A. T. & S. F.	B. R. & P.	C. & O.
C. & E. I.	B. & L. E.	B. & A.	C. & A.	N. & W.
C. R. I. & P.	B. R. & P.	C. & O.	C. G. W.	
I. R. of Can.	C. of Ga.	C. M. & P. S.	C. M. & St. P.	
I. & G. N.	C. R. R. of N. J	C. C. C. & St. L.	C. St. P. M. & O	
Mo. Pac.	C. & N. W.	I. C.	D. & H.	
M. & O.	C. B. & Q.	L. S. & M. S.	K. C. S.	
Nat. Rys. of Mex	C. I. & L.	L. & N.	N. C. & St. L.	
N. Y. N. H. & H.	C. & S.	N. Y. C. & H. R.	P. & L. E.	
P. & R.	D. & R. G.	N. P.	Southern	
St. L. & S. F.	E. J. & E.	Pennsylvania		
Wabash	Erie	Pa. Lines West		
	G. T.	S. A. L.		
	G. N.			
	L. V.			
	Long Island			
	Maine Cent.			
	O. S. L.			
	U. P.			

B. & O. uses 100-ft. tables with end carriages for Mallets. Grand Trunk has one 100 ft. table to accommodate large house. O. S. L has 100 ft. table for Mallets. P. R. R. has one 100 ft. table to avoid frogs. U. P. has some 100 ft. tables for Mallets.

Special lengths used or under consideration by above roads.

M. & O. expects to increase standard to 80 ft.

B. & M. considering use of 80 ft. tables.

Nat. Rys. of Mex. uses 80 ft. tables for Mallets.

B. & O. uses heavy end carriages so 80 ft. tables need not balance.

N. Y. N. H. & H. has built some 80 ft. tables.

P. & R. has one 85 ft. table.

A. T. & S. F. has a few 90 ft. tables to avoid frogs.

D. & R. G. uses 90 ft. tables for Mallet engines.

C. R. I. & P. considering use of 90 ft. table.

St. L. & S. F. considering use of 90 ft. tables and may install some 100 ft. to 110 ft. for Mallets.

Great Northern has some 92 ft. tables for Mallets.

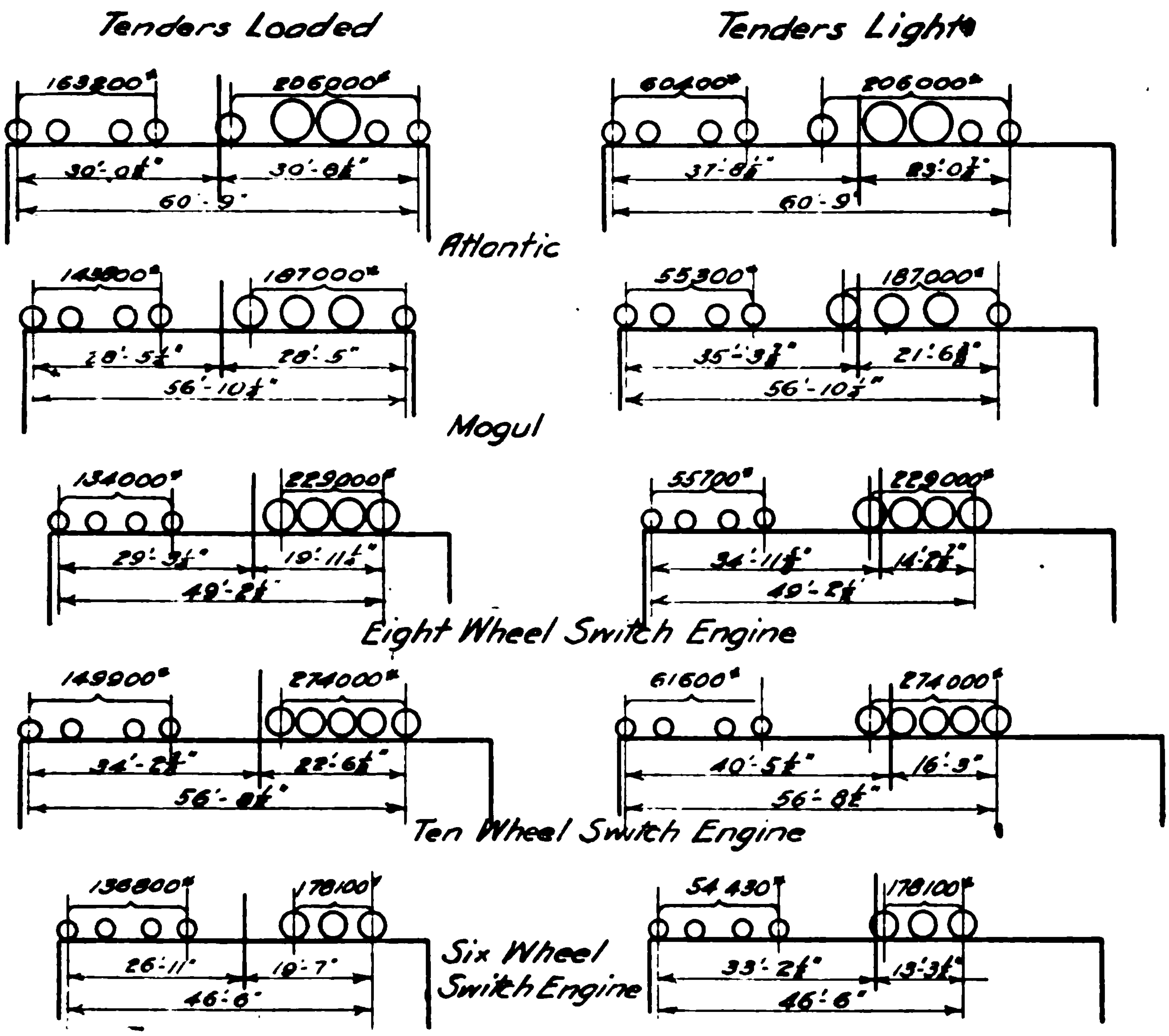
C. M. & P. S. has a few 105 ft. tables to turn Mallet engines.

Practically all roads report short tables in service on old lines but no road reported a standard length shorter than 75 ft. The standard lengths reported by various roads are as follows:

12 roads report standard length as 75 ft.
19 roads report standard length as 80 ft.
13 roads report standard length as 85 ft.
10 roads report standard length as 90 ft.
2 roads report standard length as 100 ft.

In addition several of the roads report the use of turntables longer than their standard for special purposes such as the turning of Mallet locomotives, the elimination of frogs in approach tracks, etc. The longest table reported in use is on the C. M. & P. S., and is a pony truss table 105 ft. long, weighing 175,000 lbs.

The necessity for a liberal allowance for future increase in length is shown by past experience. For some reason turntables have invariably been built only long enough for engines actually in use and frequent enlargement has been necessary. In this connection the Santa Fe reports: "In 1896 we commenced building 60 ft. tables. We used these about two years and then went to 75 ft. The 75 ft. length lasted less than one year when the new engines forced us up to 85 ft. tables."

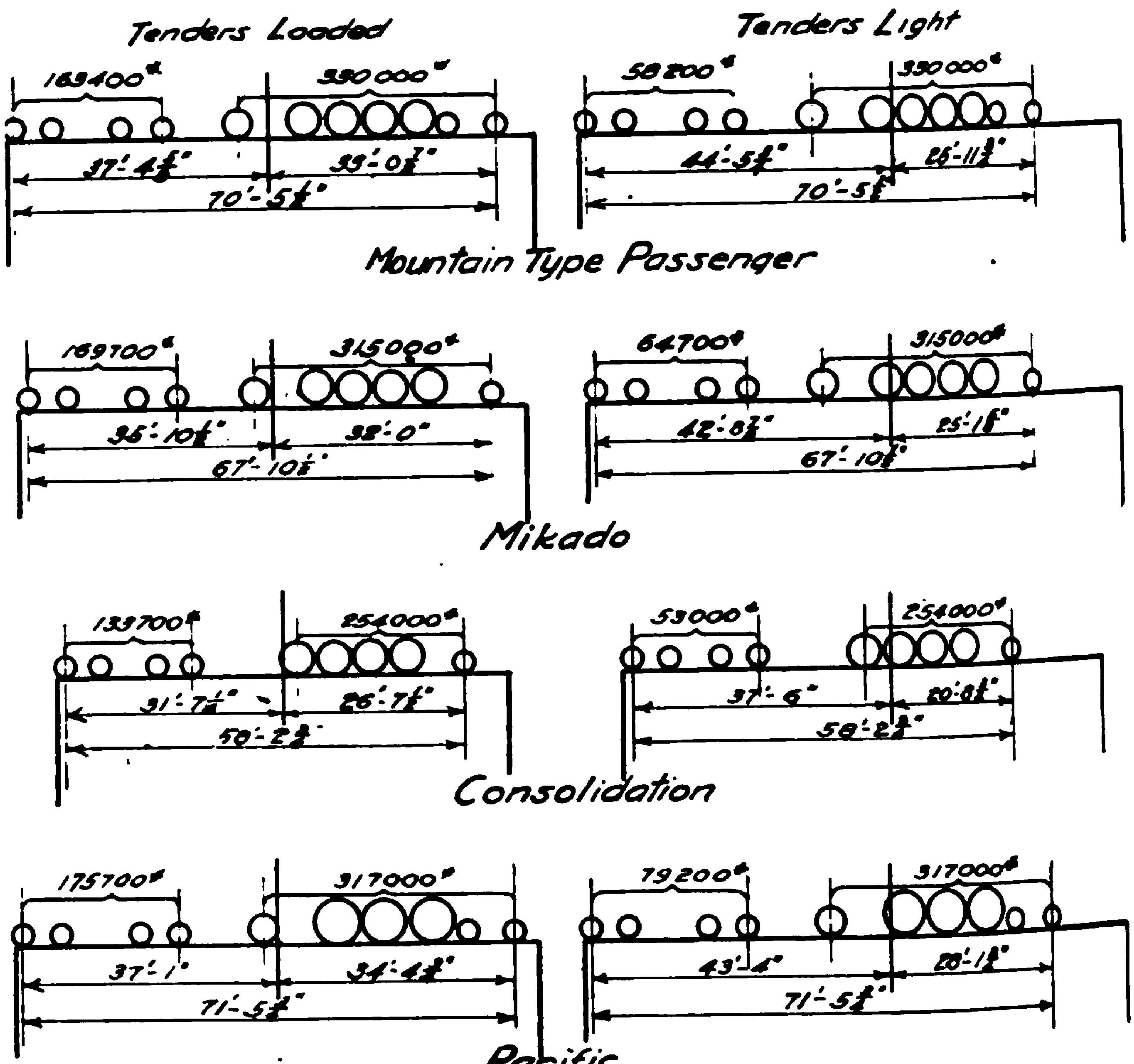


Diagrams showing location of center of gravity with reference to turntables of largest Atlantic, Mogul, 8-wheel switch, 10-wheel switch and 6-wheel switch locomotives, constructed by the American Locomotive Co.

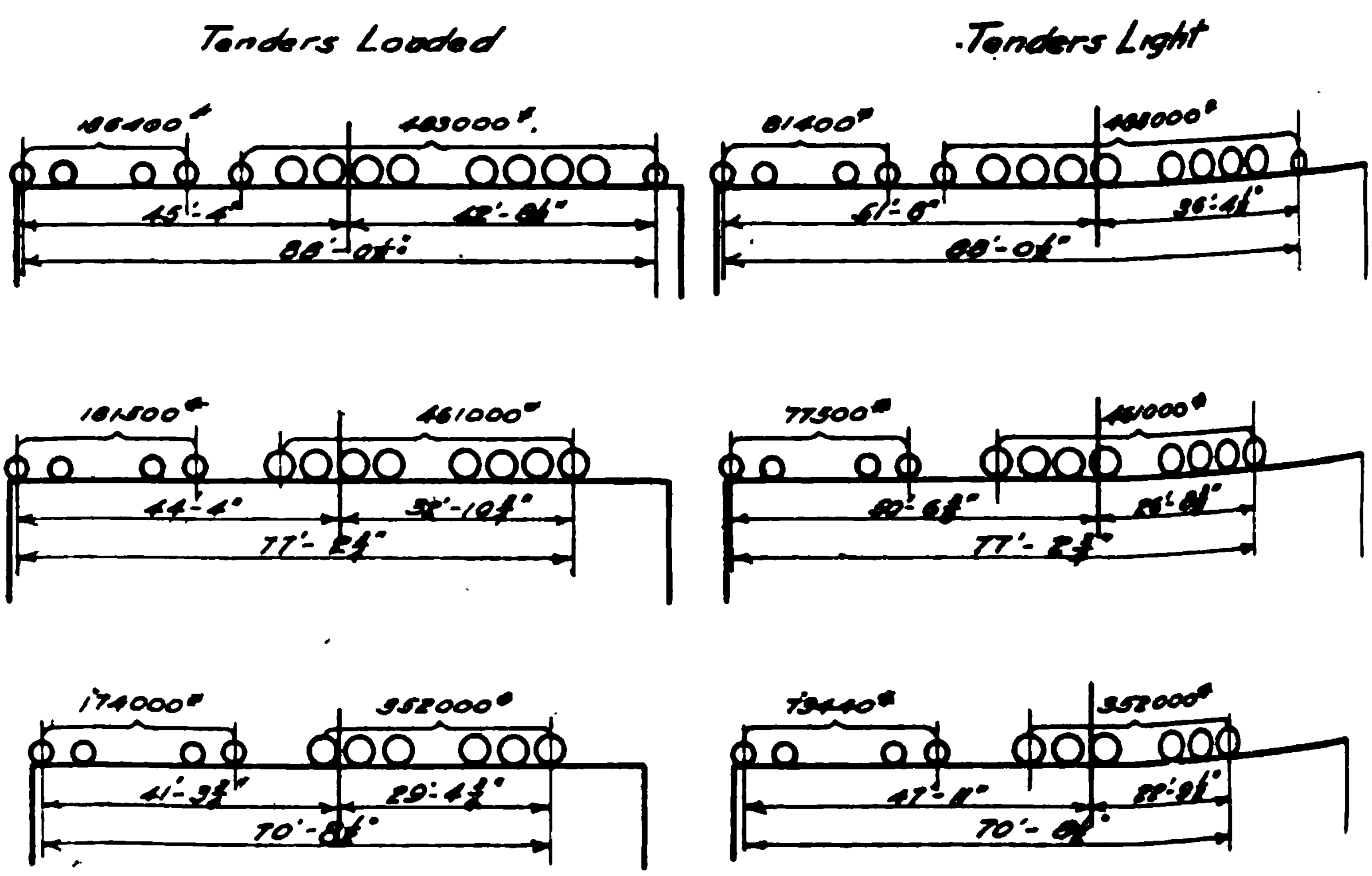
The locomotive diagrams accompanying the report show the weights, wheel bases and balancing conditions of the heaviest locomotives of 12 types manufactured by the American Locomotive Company, 6 types by the Baldwin Locomotive Works and the large Santa Fe 24 wheel Mallet compound engine. The statement showing wheelbase and balancing lengths of heavy locomotives prepared from these diagrams shows that a table 90 ft. long will balance all heavy engines under all conditions with the exception of Decapod and Mallet engines and will balance Decapod engines with part load on the tender. A table 90 ft. long is longer than the wheelbase of any locomotive, including the Mallet engines (with the exception of the 24 wheel Santa Fe Mallet) and will turn all but the Santa Fe Mallet, provided a heavy truck and motor are provided at one end to roll the unbalanced load that will rest on one end truck. Even for the largest Mallet engine (except the large Santa Fe engines) the weight on an end carriage will not exceed 50 tons. The success of such construction and operation is merely a matter of the design of the end carriages.

A number of roads are already using heavy end carriages to dispense with the necessity for balancing the locomotives. The Pennsylvania Lines West provide steel springs to reduce the shock on the end carriages.

A few roads have built tables from 90 to 105 ft. in length, several of the latter length, of the riveted pony truss design with standard steel stringers and floor beams, having been installed on the Chicago, Milwaukee and Puget Sound. The steel in the table weighs 175,000 lbs. and the entire installation probably cost from $15,000 to $20,000.



Diagrams showing location of center of gravity with reference to turntables of largest mountain type passenger, Mikado, Consolidation and Pacific locomotives, constructed by the American Locomotive Co.



Diagrams showing location of center of gravity with reference to turntables of largest Mallet compound locomotives, constructed by the American Locomotive Co.

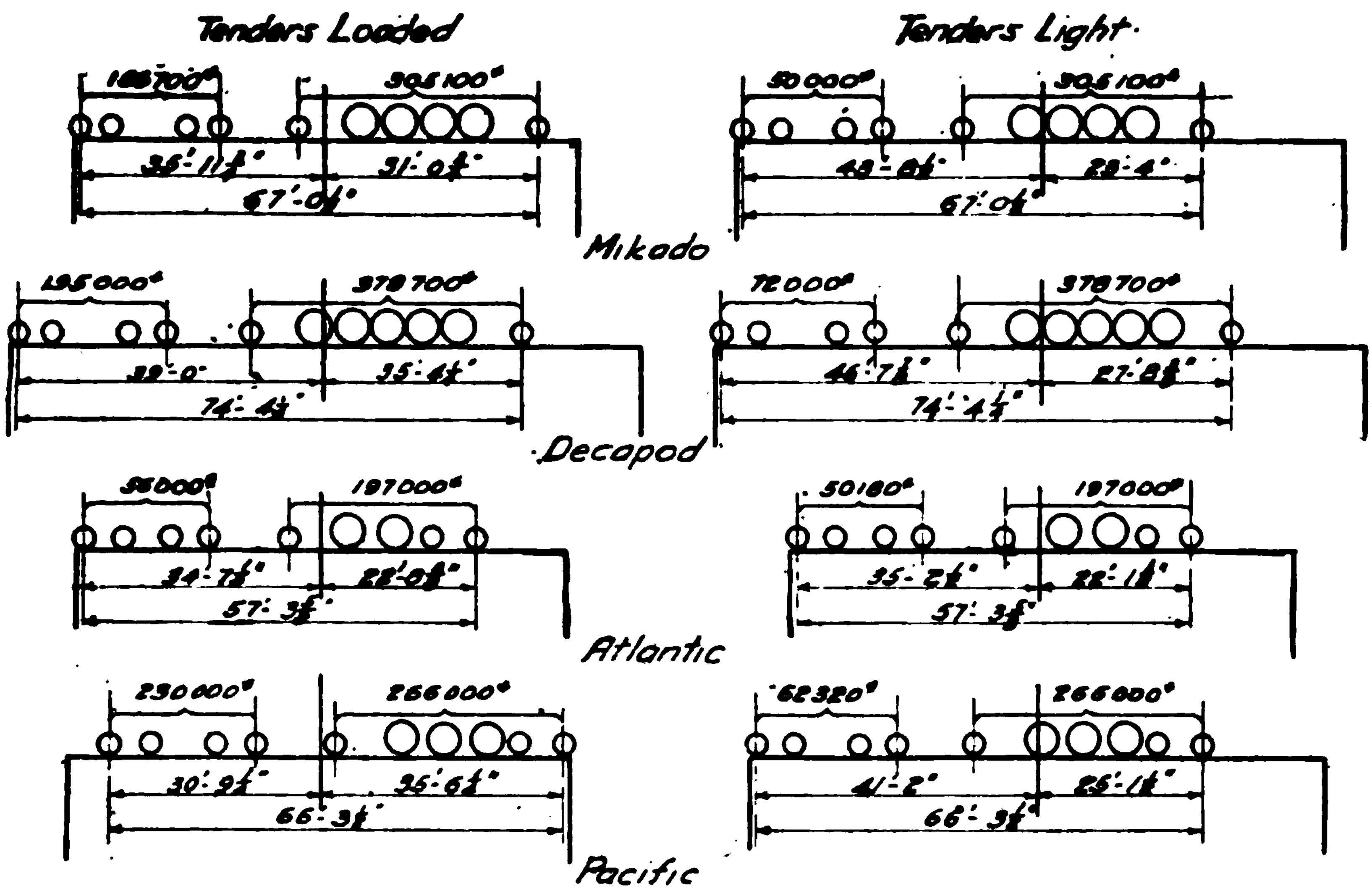
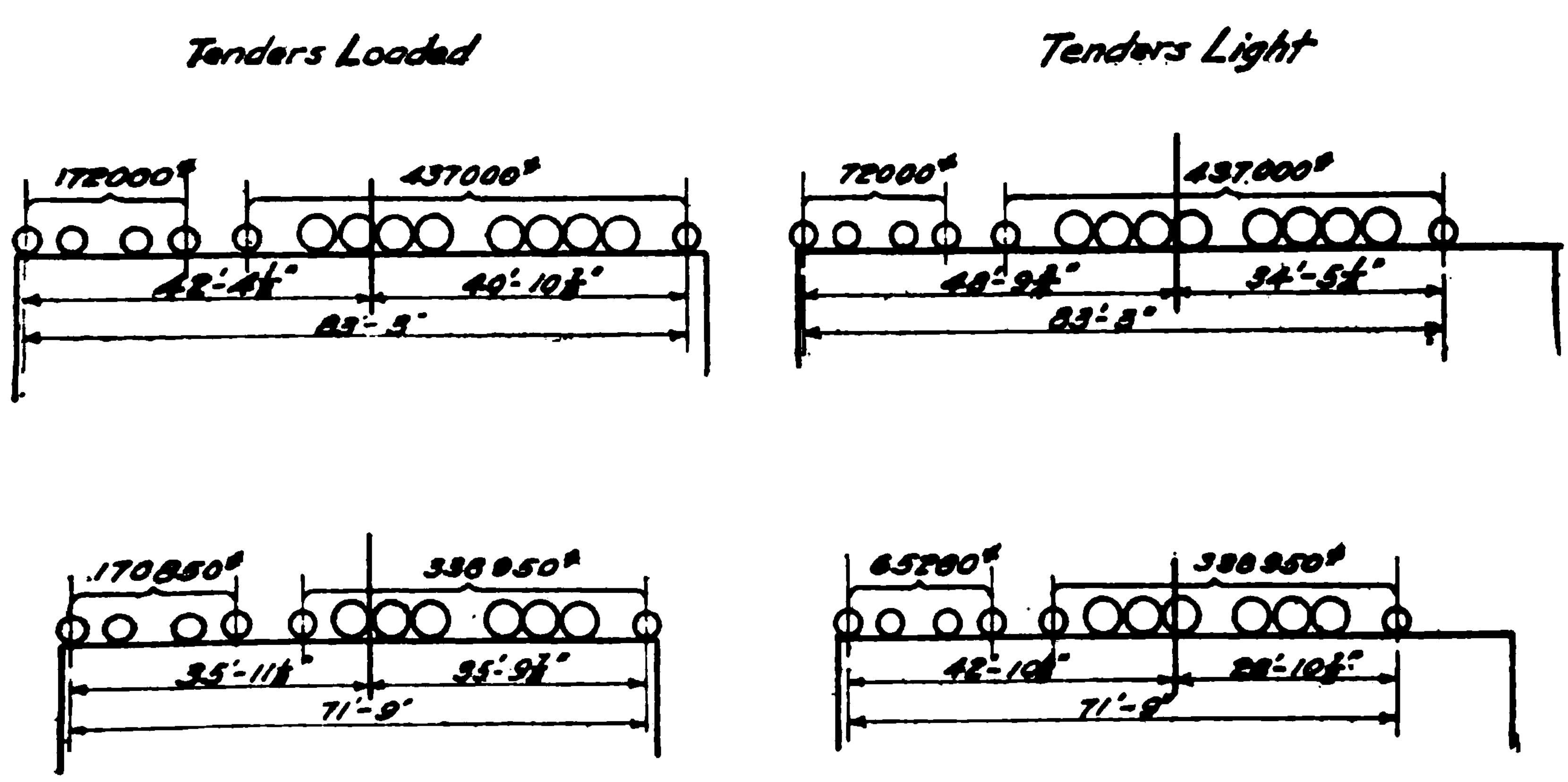
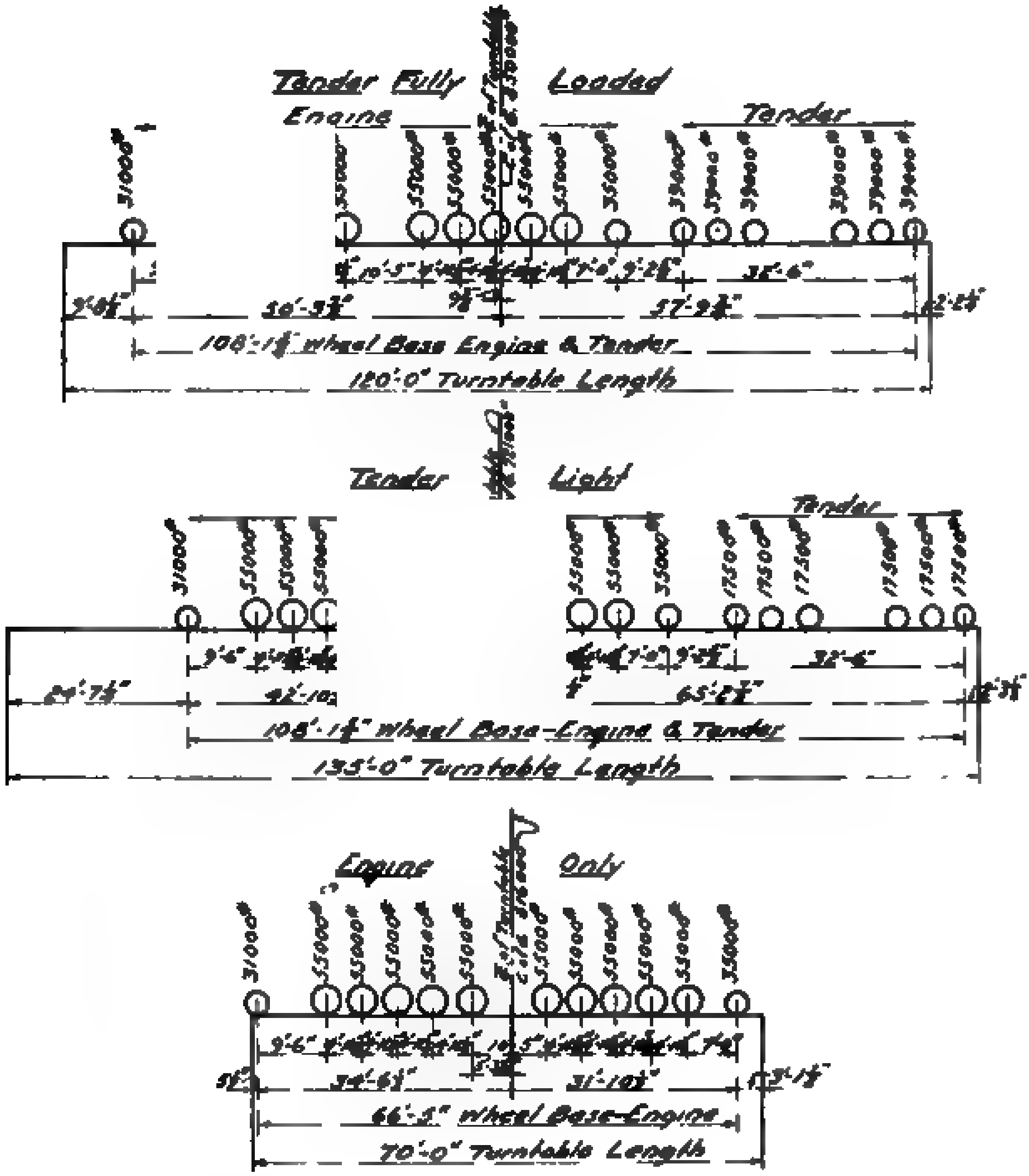


Diagram showing location of center of gravity with reference to turntables of largest Mikado, Decapod, Atlantic and Pacific type locomotives, constructed by the Baldwin Locomotive Works.



Diagrams showing location of center of gravity with reference to turntables of largest Mallet compound locomotives, constructed by the Baldwin Locomotive Works.



Diagrams Showing Turntables to accomodate A.T. & S.F. Ry Co's Mallet Compound Locomotive with and without Tender

Diagram showing length of turntable required to turn Santa Fe 24-wheel Mallet compound locomotive under various conditions.

The Santa Fe does not turn its long Mallet engines on a turntable. Mr. A. F. Robinson, bridge engineer of that system, says: "Not in favor of building extremely long turntables, that is, long enough to handle our double Mallet Santa Fe engine, a table which would have to be about 135 ft. in diameter. These can be built and operated successfully. The cost of repairs and operation, however, will, in the writer's judgment, be high." The cost of such a table would probably reach $25,000.

The Committee recommends that for standard gauge roads no future turntable be built shorter than 75 feet and that for roads that expect to use the heaviest engines, 90 ft. be adopted as standard.

For engines having wheel bases longer than 90 ft. wye tracks should be provided unless special local conditions compel the use and justify the expense of a longer table.

STATEMENT SHOWING WHEELBASE AND BALANCING LENGTHS OF HEAVY LOCOMOTIVES.

Type	Wheelbase	Required Length of Turntables with Tender Full	Required Length of Turntables with Tender Empty
AMERICAN LOCOMOTIVE COMPANY.			
Mountain type passenger,	70 ft. 5½ in.	76 ft. 0 in.	90 ft. 0 in.
Mikado,	67 ft. 10½ in.	73 ft. 0 in.	86 ft. 0 in.
Consolidation,	58 ft. 2¾ in.	64 ft. 0 in.	76 ft. 0 in.
Pacific	71 ft. 5¾ in.	75 ft. 0 in.	88 ft. 0 in.
Atlantic,	60 ft. 9 in.	62 ft. 0 in.	77 ft. 0 in.
Mogul,	56 ft. 10¼ in.	58 ft. 0 in.	72 ft. 0 in.
Eight wheel switch,	49 ft. 2½ in.	60 ft. 0 in.	71 ft. 0 in.
Ten wheel switch,	56 ft. 8½ in.	70 ft. 0 in.	82 ft. 0 in.
Six wheel switch,	46 ft. 6 in.	55 ft. 0 in.	68 ft. 0 in.
BALDWIN LOCOMOTIVE WORKS.			
Mikado,	67 ft. 0½ in.	73 ft. 0 in.	89 ft. 0 in.
Decapod,	74 ft. 4¼ in.	79 ft. 0 in.	94 ft. 0 in.
Atlantic,	57 ft. 3⅝ in.	70 ft. 0 in.	72 ft. 0 in.
Pacific,	66 ft. 3½ in.	72 ft. 0 in.	84 ft. 0 in.
MALLET COMPOUND ENGINES. AMERICAN LOCOMOTIVE COMPANY.			
2-8-8-2,	88 ft. 0½ in.	92 ft. 0 in.	105 ft. 0 in.
0-8-8-0,	77 ft. 2¾ in.	90 ft. 0 in.	102 ft. 0 in.
0-6-6-0,	70 ft. 8½ in.	84 ft. 0 in.	97 ft. 0 in.
BALDWIN LOCOMOTIVE WORKS.			
2-8-8-2,	83 ft. 3 in.	86 ft. 0 in.	99 ft. 0 in.
2-6-6-2,	71 ft. 9 in.	73 ft. 0 in.	87 ft. 0 in.

TYPE OF TABLE.

The deck plate girder type appears to be desired by all concerned, but through plate girders and pony trusses are extensively used where it is diffi-

cult or impossible to secure drainage for the deeper pits required for the deck types, especially for the longer tables. Thirty-one roads use deck plate girders exclusively. Fifteen roads use deck plate girders wherever possible and through plate girders where drainage conditions demand, one road having used a through plate girder to decrease the necessary amount of excavation, the pit being located in solid rock. Seven roads have found the drainage of deep deck pits such an unsatisfactory procedure that they have adopted the through plate girders as standard. Four roads using deck girders state they would use through girders if drainage conditions demanded. The N. C. & St. L. states it would go to great expense, say $3,000 or $4,000, to avoid through tables. The N. Y. C. & H. R. states that their turntable pit is always higher than the lowest point of the engine house drainage and therefore the choice of turntable is not ordinarily affected by the matter of drainage. The C. B. & Q. has a few through truss tables where a shallow floor is desirable. The C. M. & P. S. and C. M. & St. P. prefer deck tables, but use half through, through and pony truss tables. The Great Northern trusses through girders to overhead towers and thereby decreases the depth of pit to a minimum. The U. P. has pony trusses for its 100 ft. tables.

The Committee feels that the deck type of table is preferable to any other type on account of its low first cost, ease of operation and economy of maintenance but sees no serious objections to through tables where conditions demand their use.

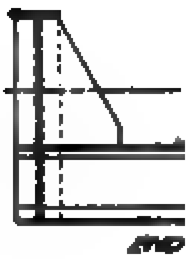
Where through girders are used the best practice seems to favor providing supports for the ties by means of steel stringers and floor beams instead of using deep ties resting on shelf angles. The deep ties are expensive in first cost and in maintenance, and promote corrosion of the girder webs and shelf angles. The steel cross girders at the center of the turntable require a depth at least as great as a standard floor system so the depth of pit need not be increased for the floor system.

The depth of pit for the shorter tables will probably never be sufficient to compel the use of short through tables, say less than 75 ft. The advantage of using through tables for the greatest lengths is indicated by the pit for the Pennsylvania 100 ft. deck turntable in which the depth from base of rail to top of catch basin is 11 ft. 2 in., while for the Norfolk and Western 100 ft. through turntable the depth is only 7 ft. 6 in.

Where through girders are used they should not be placed less than 15 ft. between centers as with a closer spacing the danger arises of men getting caught between an engine and the girder flanges.

Some slight use has been made of a shallow table that rests at the ends and center at all times and sometimes at other points, those tables being discussed more fully under "non-tipping tables."

Mr. F. G. Jonah expresses his opinion on this subject as follows: "I am inclined to think that the through turntables will be found to be the best for all long turntables, which will avoid the great depth of pit necessary for the deck tables."



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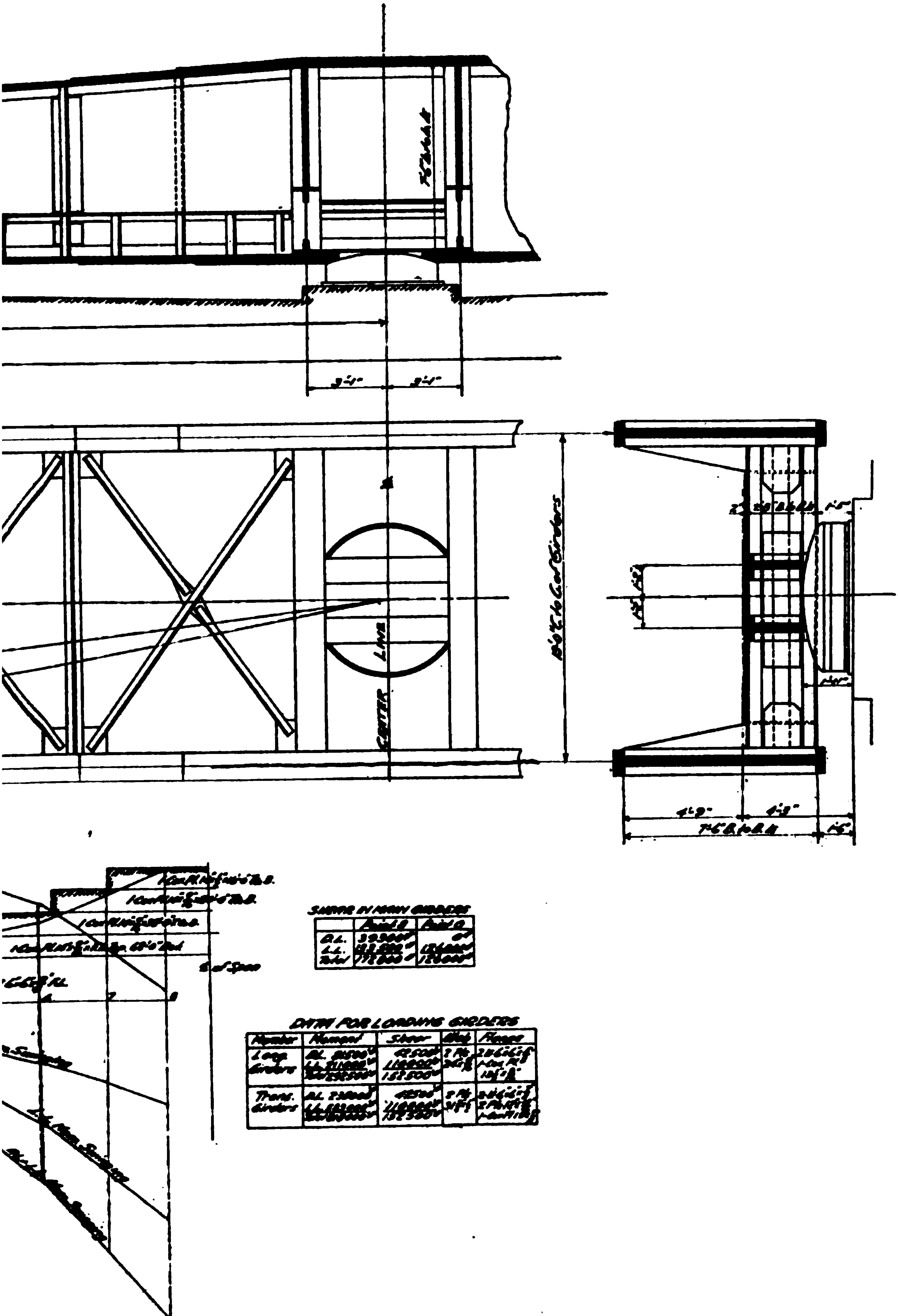
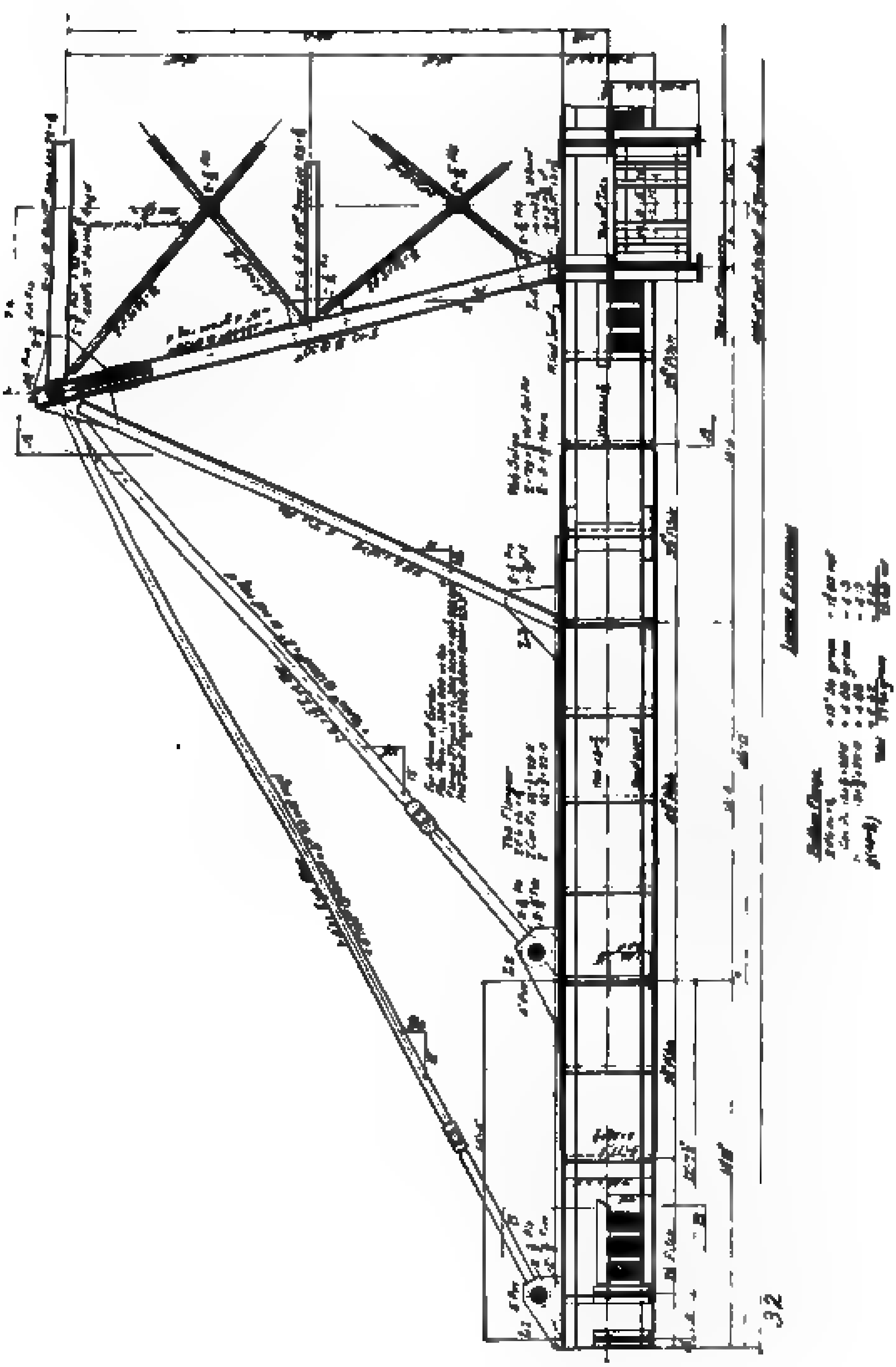
General Drawing of A. T. & S. F. Ry. System 85-ft. Standard Th



3'-1"
3'-1"
CENTER LINE
4'-9"
4'-3"
7'-6" B. to B.
1'-5"
SHEAR IN MAIN GIRDERS
DATA FOR LOADING GIRDERS

Turntable.



Standard 92-Ft. Through Girder Turntable with Through Overhead Trussing, Great Northern Ry.

Standard 100-Ft. Through Turntable, Norfolk & Western Ry.

General Drawing of Pit for Non-Tipping Turntable, Elgin, Joliet & Eastern Ry.

Loading and Stresses.

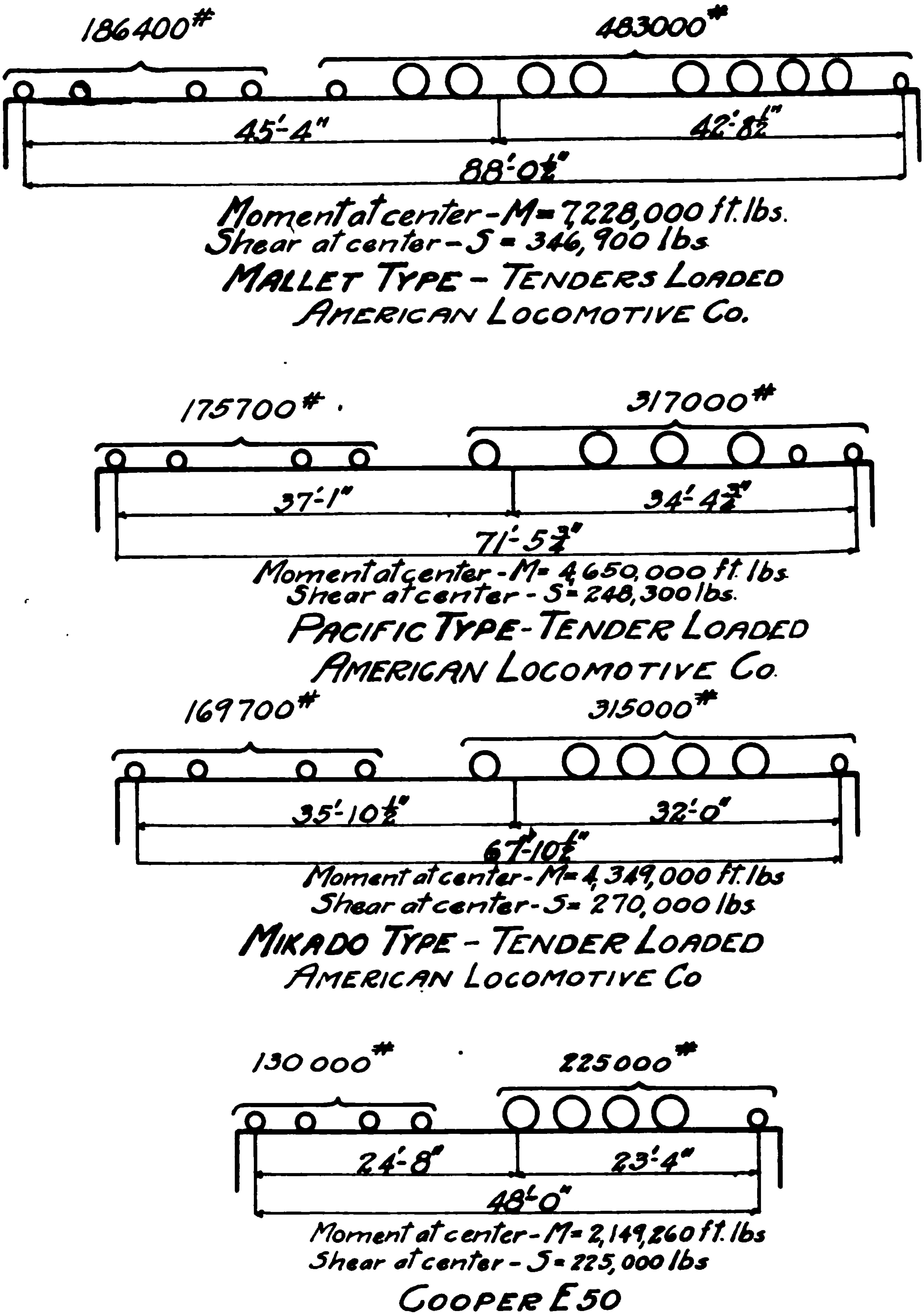


Diagram showing comparison between Cooper's E-50 and actual heavy locomotives as applied to turntable design.

The loadings and unit stresses used in the design of turntables are greatly diversified. Although Cooper's loadings are not adapted to turntable design on account of their short wheel base, 15 roads report their use in the design. The Boston & Maine, Long Island and Maine Central report the use of Cooper's E-50 (177½ tons); the Central Railroad of New Jersey, Chicago Great Western, Denver & Rio Grande, Mobile & Ohio, Philadelphia

and Reading, and Central of Georgia report the use of Cooper's E-55, (195¼ tons); the Bessemer & Lake Erie, Buffalo, Rochester & Pittsburg, Chicago & Alton and Lehigh Valley report the use of Cooper's E-60 (213 tons). On most of these roads impact is added to the stresses which are usually 16,000 lbs. per sq. in. tension and 10,000 lbs. per sq. in. shear, although in a few cases the impact is omitted and lower unit stresses are used, resulting in approximately the same weight of table.

Cooper's loadings modified by increasing the axle spacing and wheel base are used by several roads the engineers of which recognize the unsuitability of Cooper's loadings for turntable design. Among them are the Seaboard Air Line which uses Cooper's E-50 with wheel base increased 50 per cent, and the Boston & Albany which uses Cooper's E-60 with wheel base increased 10 ft.

Other roads that report the weight of engine for which their tables are designed but give no other information along these lines are the Chicago & Eastern Illinois, Chicago, St. Paul, Minneapolis & Omaha, Colorado & Southern, Elgin, Joliet & Eastern, Illinois Central, International & Great Northern, Wabash and the Chicago, Rock Island & Pacific, all of which report the use of 200 ton tables; the Cleveland, Cincinnati, Chicago & St. Louis, and Pennsylvania which report the use of 225 ton tables; the C. M. & St. P. and C. M. and P. S. which report the use of 250 ton and some 325 ton tables.

Several roads have reported the use of special loadings as follows:

Name of Road	Weight of Engine in Tons	Stresses Used in lbs. per sq. in. Tension	Shear	Remarks
A. T. & S. F.	243	8,000	4,000	
B. & O.	230 ton Mallet	10,000	6,000	
C. & O.	314 ton Mallet	10,000 Negative Moment.... 12,000 Positive Moment...	6,000	No impact
C. B. & Q.	213½ ton Mikado	9,000	.....	
D. & H.	Cooper's E-60	8,000	.....	
D. L. & W.		10,000	6,000	
Great Northern 80'	180	10,000	.....	No impact
Great Northern 92'	258½ ton Mallet	12,000	.....	No impact
I. R. of Can.	200	8,000	.....	
K. C. S.	240 ton Mallet	12,000	.....	
L. S. & M. S.	210 ton Switcher	11,000	7,500	

Road	Weight	Tension	Shear	Remarks
. & N.	192	15,000	......	Impact allowed
Mo. Pac.	200	10,000	7,500	
N. R. of M. 75'	200			
N. R. of M. 85'	254 ton Mallet			
N. Y. C. & H. R.	246 ton Mallet	10,000	7,500	
N. Y. N. H. & H.	190 ton Pacific	16,000	10,000	Impact allowed
N. & W.	9,000 lbs. per lin. ft. on one arm; 7,000 lbs. per lin. ft. on both arms	10,000	......	No impact
Nor. Pac.	219½	8,000	......	
. & L. E.		12,000	......	Deflection of ends not over ⅛ in.
t. L. & S. F.	Cooper's E-55 and special Pacific and Mikado	10,000	10,000	50 per cent impact
outhern	263 ton Mallet	10,000	......	
. P.	300 ton Mallet	10,000	......	

Turntables should be so designed that the deflection of the ends will not e so great as to cause both ends to drag while turning heavy engines, and should not be necessary to place the rails on the table too high above the proach rails to accomplish this as that will result in too great a drop of the ds when an engine reaches the end of a table. In general the rails on the

table should not be more than ¾ in. above the approach rails and should come down level while engines are passing on or off. A deflection of ½ in. at each end then will leave ¼ in. clearance over the circle rail while turning. The unit stresses should be so chosen that the deflection of each end will be not greatly in excess of that amount.

Although a bridge designed for Cooper's E-50 or other Cooper's loading will support without any increase in stress over that used in the design actual modern engines considerably heavier than the Cooper's loading (on account of the longer wheelbase of the modern engines distributing the load over a greater length of bridge) the same engine on a turntable will cause the stresses that affect the deflection of the ends to very materially exceed those used in this design, for the reason that the longer wheelbase increases the negative bending moment on a turntable. This is well illustrated in the diagram comparing the effect and appearance of Cooper's E-50 loading to modern heavy Mikado, Pacific and Mallet type engines which cause stresses in bridges approximately equal to those caused by Cooper's E-50. On a turntable the negative bending moment at the center corresponds to that caused by Cooper's E-100 for the Mikado, E-110 for the Pacific and E-170 for the Mallet. If the turntable were designed for any such unreasonable values of Cooper's loadings the stresses in other parts would be increased out of all proportion to the requirements.

The reason why Cooper's loadings can not be used in turntable design is readily apparent from the above. It appears that the tables should be designed for the heaviest actual engine in service anywhere that could use them.

The unit stresses should be chosen low enough to keep the deflection down to a minimum, 10,000 lbs. per sq. in. for tension and the equivalent for compression, and 6,000 lbs. per sq. in. for shear being reasonable values. With those stresses it is not necessary to add any allowance for impact except at the ends where live load stresses in all parts subject to pounding should be increased 100 per cent to provide for impact.

Drainage.

The drainage of turntable pits, which has always been very important, becomes a much larger problem for the longer tables and deeper pits. Many engineers have had experience with pits that flooded during heavy rains or from flood water backing up through the drains.

Although tables can be operated under such conditions, the results are very bad, particularly on account of the damage to the center. In addition the water in the pit sometimes freezes and stops operation. After floods it is frequently necessary to take the center apart for cleaning and oiling with consequent delays to locomotives. While such delays might not seriously inconvenience operation at an outlying point where few engines are turned, they cannot be tolerated at busy terminals where it is of the greatest importance that the turntables be maintained in continuous service.

In former years when shorter tables were used the depth of the pit was not great and drainage could easily be secured without serious trouble or the accumulation of water would not be deep enough to cause trouble.

In case the lowest point of the engine house drainage is lower than the bottom of the turntable pit, the drainage of the pit can be made secondary to that of the engine house.

In any case the most efficient, economical and satisfactory drainage is provided by catch basins and gravity drains where the highest water in the outlet is lower than the bottom of the pit. Where this condition does not obtain the problem of drainage can be simplified in several ways, some of which are as follows:

Use of through type of table, thereby decreasing the depth of pit.

Use of shallow, non-tipping tables, that is, tables that rest on three or more points while turning.

Use of waterproof pits, with sumps and pumping.

Little has been done to handle the situation by waterproof pits, sumps

and pumping and it appears that the extra expense of waterproofing pits and providing and operating the pumps (even though they may be automatic), and the neglect that may be expected combined with the very deep pits necessary for modern deck turntables, is so great as to indicate the desirability of using through girders, provided direct gravity drainage can be secured for the through pits, but it also appears that a careful comparison of expense should be made before the through table is adopted.

Aside from occasional pumping of pits during floods or when drains stop up or for other special reasons, the only cases of regular pumping from sumps and ideas along that line that have been reported, are as follows:

The A. T. & S. F. contemplates water-proofing one pit and putting a trap in the outlet to prevent the river from backing into the pit. The C. C. C. & St. L. states that in case of difficult drainage the use of a water-proof pit with deck girders should be considered and compared with the cost of a through table. The E. J. & E. has one case where the sewer will be higher than the bottom of the pit. A manhole will be built a short distance from and lower than the pit. The water will be accumulated here and ejected by a cellar drainer, operated automatically by water pressure. The Mo. Pac. has one pit (among others) in which water backed up during floods. The drain was led into a sump and during rains the water that accumulates in the sump is raised by an ejector operated by steam from the shops. No special precautions were taken to waterproof the pit. The circle wall is of concrete and the pit is paved with brick laid flat with cement mortar joints. When the sump was constructed precautions were taken to make all surface water drain away from the pit. The Long Island reports: "Drainage not usually required," presumably on account of their pits being located in the sands of Long Island where the water seeps away.

Flooring Over Pits and Tables.

The old practice of flooring over the entire turntable pit appears to have almost entirely disappeared. Only two roads report flooring over the entire pit. The Great Northern reports that all pits are open except in extreme cases. At Cascade tunnel the entire turntable and pit are housed in. The Lehigh Valley states that pits are open generally. One pit is covered entirely to provide a driveway for a fire engine and one pit is covered entirely to keep the snow out.

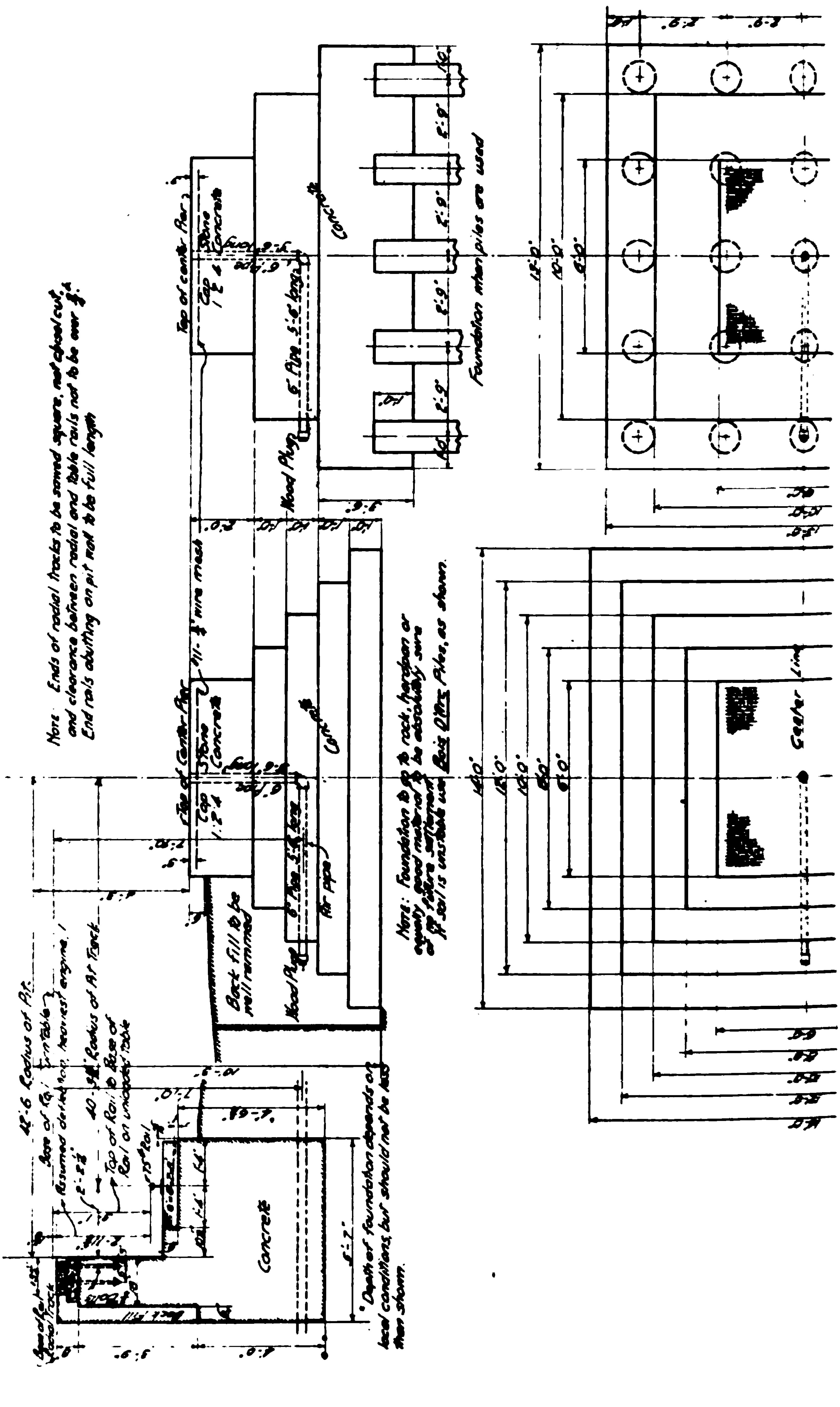
It is the invariable practice at the present time to use standard bridge ties on the stringers of through tables or on top of deck tables, with occasional ties long enough to support footwalks outside of the locomotives. The total width of the floor is 14 ft. to 16 ft. and sometimes foot railings are provided. In a few cases railroads have reported the use of pipe handrails on each side of turntables.

Center Foundation.

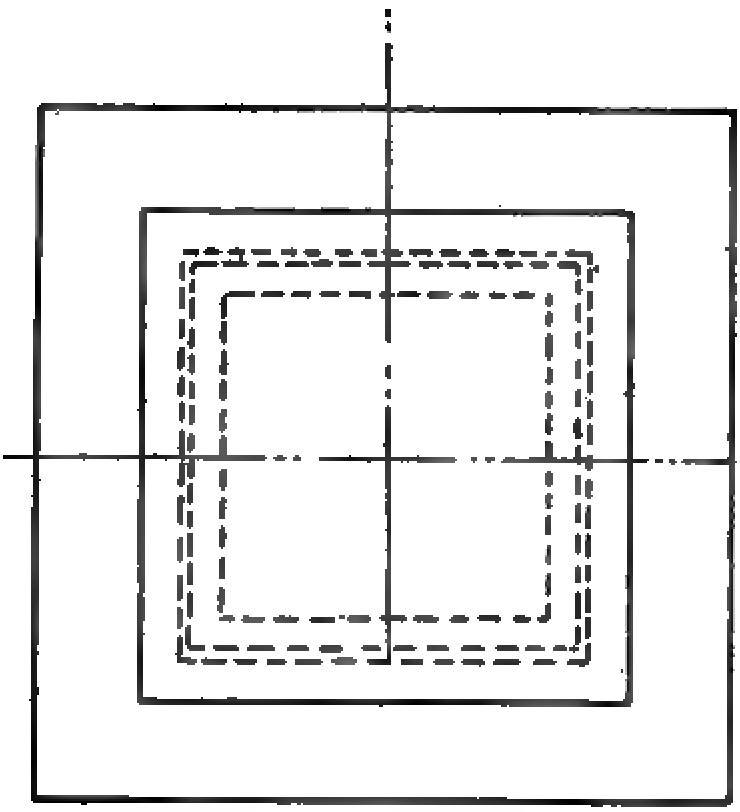
All railroads replying to the circular uniformly report the use of concrete foundations and the necessity of great care in construction of the center foundation. The great majority reported bases 12 ft. sq. on 16 piles; in many cases it is stated on the plans that footings must rest on bed rock or on piles. Footings as large as 16 ft. sq. with 49 piles were reported. Many roads reinforce the top or bottom of the center concrete or both. The cap, especially on old foundations, is frequently of stone. When installing new tables on old foundations requiring a change in elevation of the top of the center it is quite customary to cast a reinforced concrete capstone of proper thickness, which when properly hardened is substituted for the old capstone during the changing of the tables.

Many cases were reported of the settlement of centers having been stopped by excavating a trench around the footing, extending down two or three ft. deeper than the old footing, and underpinning the old foundation as well as extending the base by filling the trench with concrete, piles being driven where necessary.

The Chicago & Alton report the detailed method of carrying out such



Foundation Plan for Standard 85-ft. Through Turntable, A. T. & S. F. Ry.



PLAN.

Method Adopted for Strengthening Weak Foundations under Turntable, Chicago & Alton R. R.

a piece of reinforcement as follows: "We installed three new 90 ft. through turntables. In doing this we changed out three old 65 ft. deck tables and operating conditions were such that it was necessary for us to keep the old ables in service up to the last minute. The old centers were on natural founlations and in every case they had settled from two to eight in. so that it was not necessary to block up with a grillage placed between the top of the old foundation and the bottom of the center casting. We drove a row of pilng around the old center and built a semi-reinforced concrete wall around he existing center. The top of the old center foundation was located about en in. above the new concrete enclosing wall so there was no interference on

account of the new foundation wall. We cast a large reinforced concrete slab outside of the pit and when the old turntable was removed from the pit, the old capstone on the old center foundation was pried out and the new slab swung into place with a derrick car and leveled up on top of a mortar bed placed on top of the new enclosing foundation. The center casting for the new 90 ft. tables takes bearing on this large slab."

The practice of a number of roads that appear to take unusual precautions in this matter is as follows: The A. T. & S. F. plan calls for a footing 13 ft. square with 25 piles. A note on the plan says: Foundation to go to rock, hardpan or equally good material to be absolutely sure of no future settlement. If soil is unstable use piles." The B. & L. E. plan says: "Piles as shown (25) on swampy or filled ground: 15ft.x15ft. and rails (no piles) on natural bed, dry sand or moderately dry clay: 11ft.x15ft. (no rails) on dry gravel, hardpan, thick bed of dry clay: 8ft.x8ft. on shale and rock; increase width 1 ft. for every 2 ft. depth below 4 ft. from casting. When piles are used, excavate to ground water level. If there is no ground water use half the number shown of concrete piles."

B. & A. 15 ft. square and 25 piles.

C. & O. 12 ft. square and 25 piles.

C., B. & Q. Hexagonal shaped center 15 ft. wide with 19 piles.

C. M. & P. S. 10 ft. 6 in. square and 25 piles.

C. R. I. & P. 12 ft. 6 in. square and 25 piles.

D & H. 15 ft. square and 41 piles or less according to conditions.

Erie 14 ft. square and 25 piles.

I. C. 25 piles where not on rock.

K. C. S. Top reinforced with three layers of rails, top surface of top rails level with concrete. Six rails in top layer, eight in next, ten in next.

Long Island. Heavily reinforced top and bottom.

M. & O. 14 ft. square and 25 piles.

N. C. & St. L. 13 ft. square and 25 piles.

Nat. Rys. of Mex. 16 ft. square and 49 piles.

N. Y. C. & H. R. 13 ft. square and 25 miles piles.

N. & W. 16 ft. square and 25 piles.

If there is any possibility that air tractors may be used at any time in the future it is good practice to embed an air pipe in the concrete, bringing it to the surface of the concrete at the center of the cap.

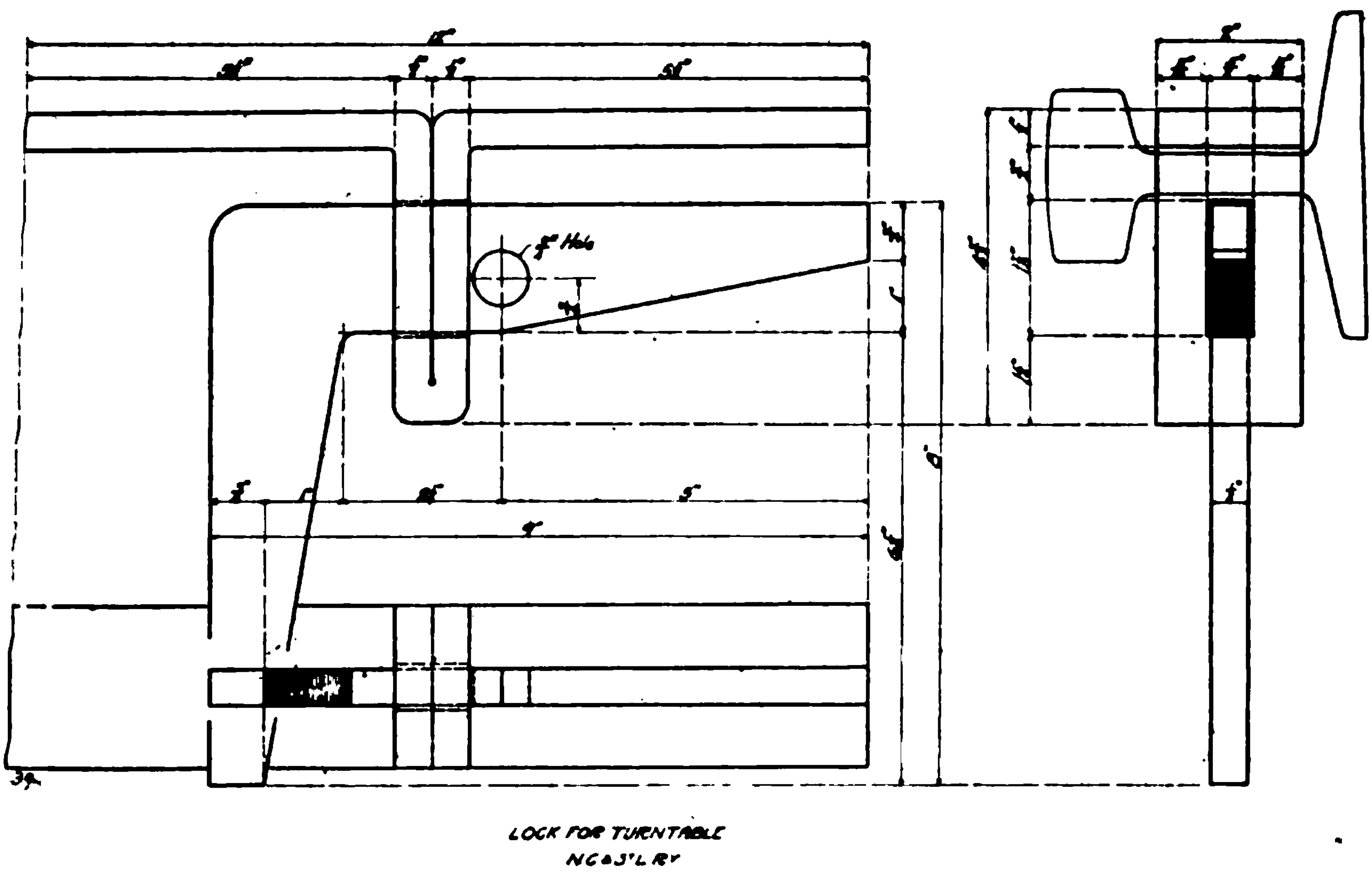
Locks.

Twenty roads report the use of the old fashioned wrought iron or wooden bar with wide ends forming an I shaped lock, sliding by hand between the webs of the rails, sometimes operated by a hand lever.

Five roads report the use of power brakes exclusively for holding turntables in position and several others report the use of power brakes on all tables operated by tractors.

Six roads report the use of a chair on the coping timber between the rails of each approach track into which drops the free end of a hinged bar, the fixed end of which is attached to the end ties on the table.

Five roads report the use of a chair on the coping timber between the



Lock for Turntable, N. C. & St. L. Ry.

rails of each approach track into which slides a tongue or toggle which moves between guides attached to the end ties of the table.

Five roads report the use of a socket in the circle wall for each approach track, into which slides a toggle bar or tongue attached to one of the turntable girders and operated by hand lever.

Five roads merely report the use of locks but do not describe the type.

The reports of a few roads are as follows:

C. R. R. of N. J. Sliding tongue on top of ties working in guides and operated by a lever which also operates a dwarf semaphore signal placed on top of the girders used at congested points where power is used. No lock where table is operated by hand.

C. M. & St. P. Usually a hand latch although in a number of cases it is operated by the man in charge of the motor.

K. C. S. Bar which is dropped over, engaging the rails.

Lehigh Valley. At important points locks and signals are provided. A sliding bolt engages a socket in the circle wall. Driven by a spring. Withdrawn by a cable.

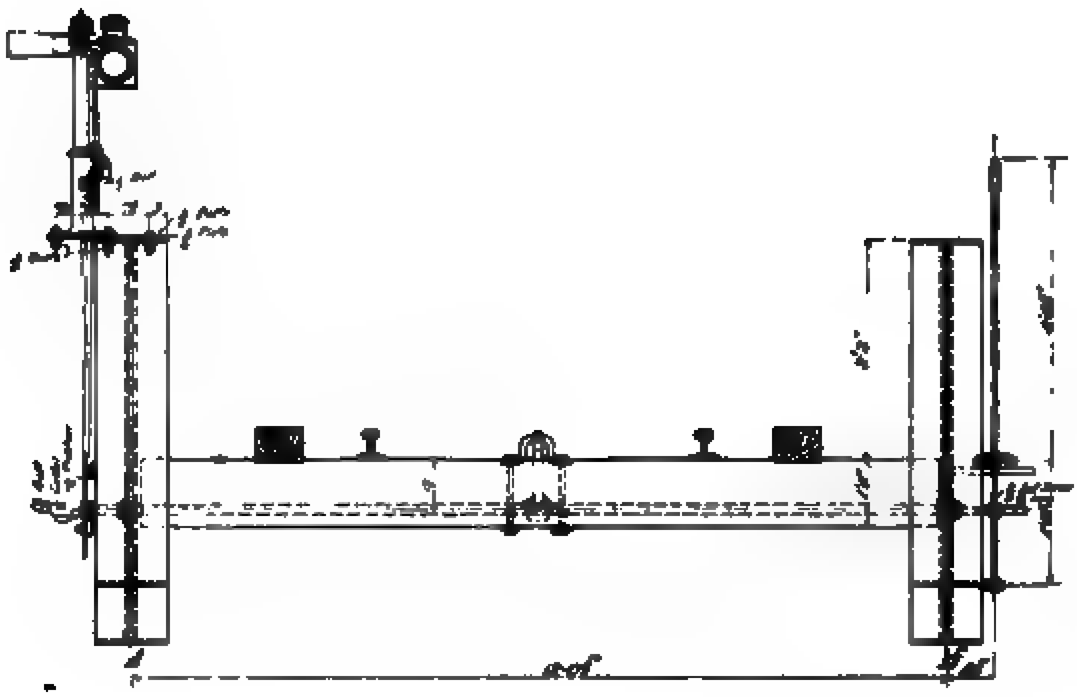
The Committee finds no necessity for locks where tractors are used, 'he power brakes being considered sufficient.

In all cases where tables are turned by hand locks should be provided. The simple I-shipped forging, sliding between the webs, answers the purpose is well as a more expensive and elaborate lock. Although it is convenient to have such a lock connected so that it will slide to and fro by the manipulaion of a hand lever, it can be satisfactorily operated by hand, rings being ttached to the forging for ease of handling if considered necessary.

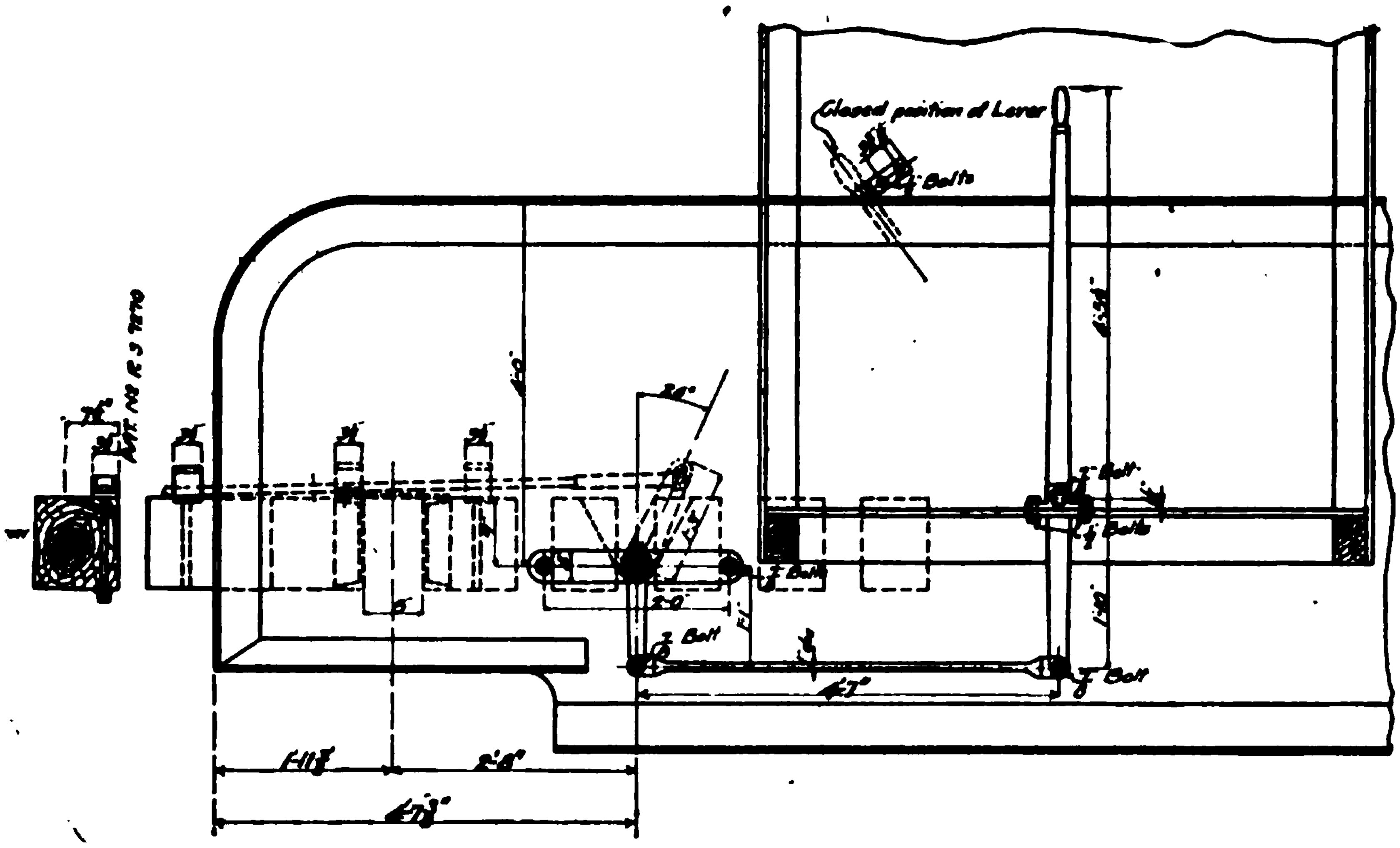
At outlying points it might be advisable to provide a locking attachment o hold the table in a fixed position to keep boys from playing with the table nd getting injured.

Power for Turning.

Electric power where available has the preference on practically all roads. urning by air motors appears to have the next preference for outlying points here tables are not much used and where current cannot be obtained and



Latch for Locking Turntables, Central R. R. of New Jersey.



Latch for Locking Turntables, Central R. R. of New Jersey.

where trouble with air motors, necessitating turning the table by hand, will not be serious. Gasoline engines are recommended for turning tables where electric current cannot be obtained and where liability of freezing renders the use of air motors objectionable.

A few roads report the use of steam tractors on their tables.

Expressions from a few roads are as follows:

A. T. & S. F.:—Air motors will work satisfactorily if proper care is exercised in the arrangement of the drainage to prevent freezing. The motor is not fool-proof, but it has given extremely good service on our lines.

B. & L. E.:—We would use no other power than electricity unless current could not be obtained.

B. & M.:—We have installed many gasoline motors, but are changing to electric motors wherever current can be obtained.

C. R. R. of N. J.: We use air supplied from locomotives.

C. & N. W.:—Electricity has proved very satisfactory and has been installed at all points where we generate our own power.

C. R. I. & P.:—We use air motors. We do not find these very satisfactory on account of the motors freezing up on our northern territory. In the future we will probably use electricity where current is easily obtained.

C. C. C. & St. L.:—We find air motors unsatisfactory on account of freezing in cold weather and more expensive to maintain than electric.

E. J. & E.:—We recommend overhead collector rings as we have had trouble from wires placed underground on account of dampness causing short circuits and ice in the pit affecting low collector rings.

Great Northern:—Gasoline is used only where air and electricity are not available. The objection to gasoline is the increased fire risk.

I. C.:—Air gives trouble in cold weather unless air pipes are placed underground.

Non-tipping Tables.

A short time ago there was considerable talk of having special non-tipping turntables, that is, the tables that would rest at all times at both ends and the center and in case of long tables, at intermediate points, which turntables would be quite similar in design to the present transfer tables. This practice has not developed to any remarkable extent, however, but some roads

[illegible]

Locking Device for Turntable, Lehigh Valley R. R.

are using a modification in providing heavy end carriages and motors on balancing turntables, so that for the shorter engines the turning can be performed in the regular way with the least work and for the longer engines balancing is not necessary as the motors are powerful enough to pull the loaded end truck around the circle.

The experiences of various roads along these lines are as follows:

Santa Fe: " Since we put the Mallet into service we have had to turn the table around when the load was not perfectly balanced. The motors we have been using are generally strong enough to handle the tables under these conditions.

The B. & O. and Nat. Rys. of Mex. report that their 80 ft. tables have end carriages for carrying unbalanced loads.

E. J. & E.: "We have three non-tipping tables located at Joliet, South Chicago and Gary. These tables are very hard to operate at times when the machinery is out of order. It is necessary to use a wrecking crane or a locomotive with tackle in order to get engines in and out of the roundhouse, while with the center bearing tables all that is necessary in case the machinery is out of order is to remove one of the gears and our largest locomotives can be easily turned by two men. The only advantage I know of in the use of end bearing tables is the reduction in the depth of the pit. This makes two spans of the table which greatly reduces the depth of the girders.

"Our 80 ft. center bearing tables are equipped with 15 H. P. electric motors, and it requires one minute and two seconds to turn a class 'A' engine on these tables. The 70 ft. end bearing table at Gary is equipped with a 30 H. P. electric motor and requires two minutes and eighteen seconds to turn a class 'A' engine. A 60 ft. end bearing table is equipped with a 10 H. P. electric motor, and requires two minutes and eighteen seconds to turn a class 'A' engine. The above is the average time required to make a complete revolution after the engine has been spotted from a dead stand still to a dead stop with the motor running at full speed. From this you will see that the speed of the center bearing tables is much greater than the end bearing table, and requires considerably less power to operate.

"We have experienced more or less trouble with the end bearing tables breaking in two in the center, and it has been necessary to reconstruct the center several times on this account. There is considerable expense in renewals of wheels on end bearing tables. These are short lived on account of the great weight they are required to carry."

N. & W.: "Where power is used balancing is not necessary. End wheels are made very heavy of cast or rolled steel, four wheels to each end with special cast wheel bearings arranged with oil boxes."

Southern Railway: " We have in service one table of the non-tipping type, that is, two arms or spans non-continuous at the center. This table gives a great deal of trouble on account of the wearing of the bearings of the end wheels. The pressure is very great at the end wheels and the wheels are equipped with roller journal bearings. These bearings wear very rapidly and allow the wheels to slew, with the result that the circular rail is pulled out of line, or the attachments of the wheels themselves are broken from the table. Our experience with this type of table has been decidedly unfavorable."

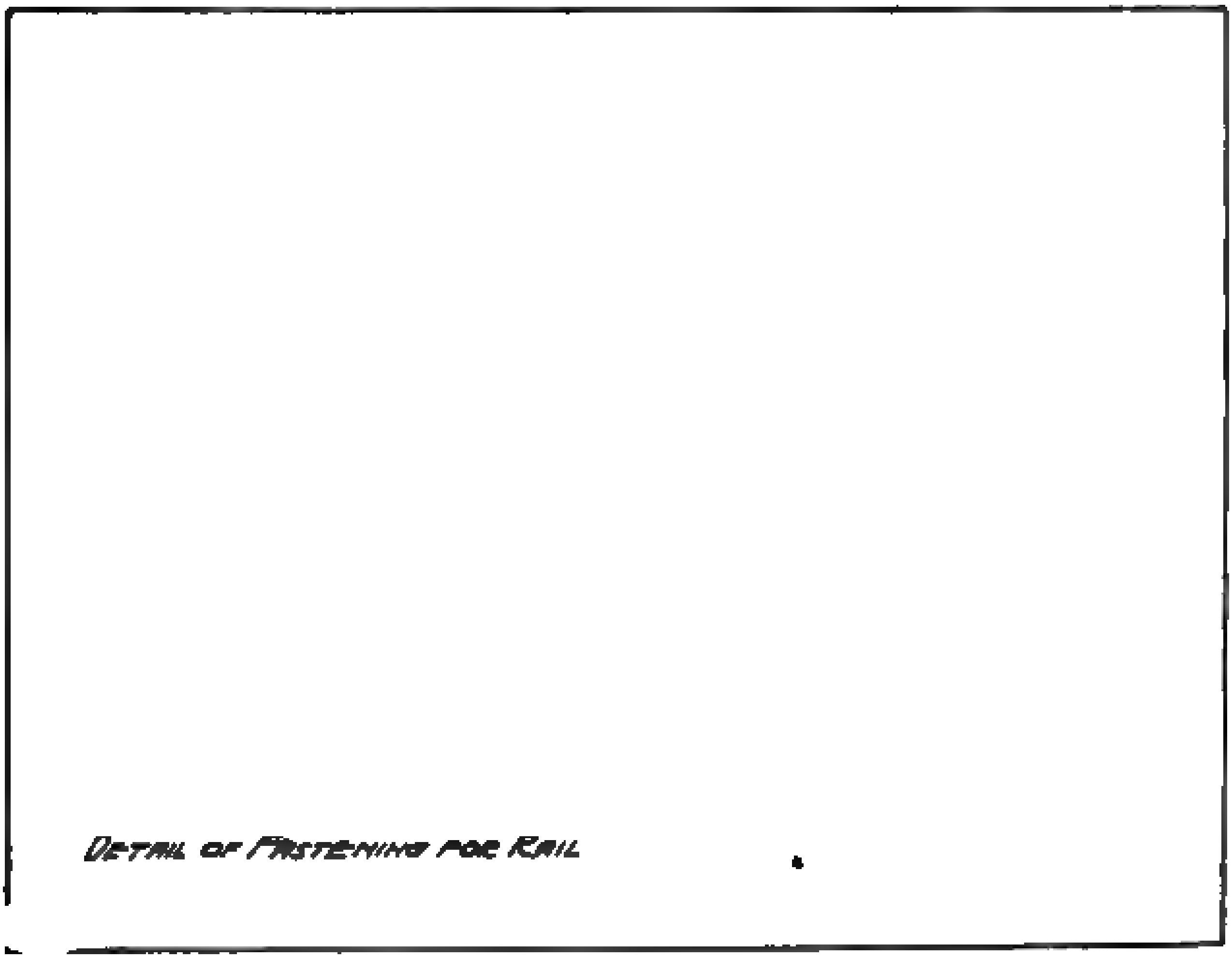
Circle Wall.

Thirty-five roads report the use of timber coping on the circle wall for the support of the rails of the approach tracks and of short ties set radially and resting on the concrete for the support of the circle rail, some using creosoted timber, tie plates and screw spikes.

Five roads report timber coping but rest the circle rail directly on the concrete, as follows: C. B. & Q., C. R. I. & P., C. St. P. M. & O., I. C., L. S. & M. S.

Nineteen other roads report as follows:

B. & A.:—The face of the circle is formed by a 10 in. curved I-beam anchored to the concrete. The ends of the approach rails are attached to the I-beam by bolts through the rail and flanges of the beam. The



Connections of Rails to Circle Wall, Boston & Albany R. R.

circle rail rests on 6in.x½in.x12in. steel plates every three ft., which are held down by anchor bolts set in concrete.

B. & M.:—In some cases the rails rest on steel plates on the concrete and are held down by anchor bolts and clips.

B. R. & P.:—The rails are secured by bolts and bevel washers to channel irons set in the concrete coping in later designs.

C. of Ga :—The approach rails rest on coping timber. The circle rail is buried in concrete up to the bottom of its head. There are placed in the concrete under the circle three short pieces of old rail 2 ft. long under the position of the trailing wheels where the table is set for the main leads.

C. R R. of N. J :—The approach and circle rails are supported on castings. The concrete under the approach tracks is reinforced by two rails each 12 ft. long embedded upside down with their flanges level with the top of the concrete.

C. & E. I.:—In some cases the approach and circle rails rest on steel plates.

C. G. W.:—The approach and circle rails rest on concrete and are held down by rail anchors.

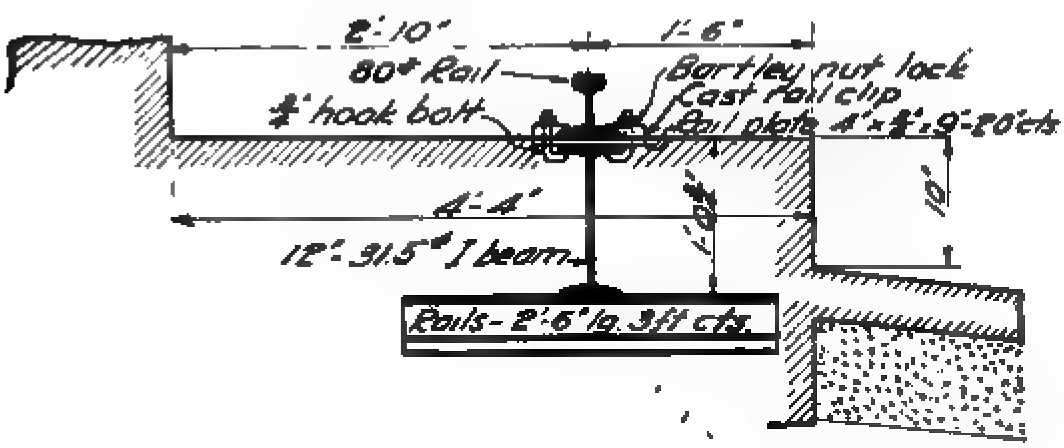
C. C C & St L.:—The approach and circle rails rest on ¾ in. steel plates placed 20 in. centers and embedded in the concrete. At the main tracks the circle rail is carried on curved 12 in. I-beams 20 ft. long embedded in concrete and resting on short sections of rail 2 ft. 6 in. long every 3 ft. Similar arrangements should be used for the approach rails at the main points as the ¾ in. plates resting directly on the concrete are not adequate.

D & H.:—The approach rails rest in riveted steel plate chairs anchored to the concrete. The circle rail rests on timber ties bedded in the concrete or directly on the concrete.

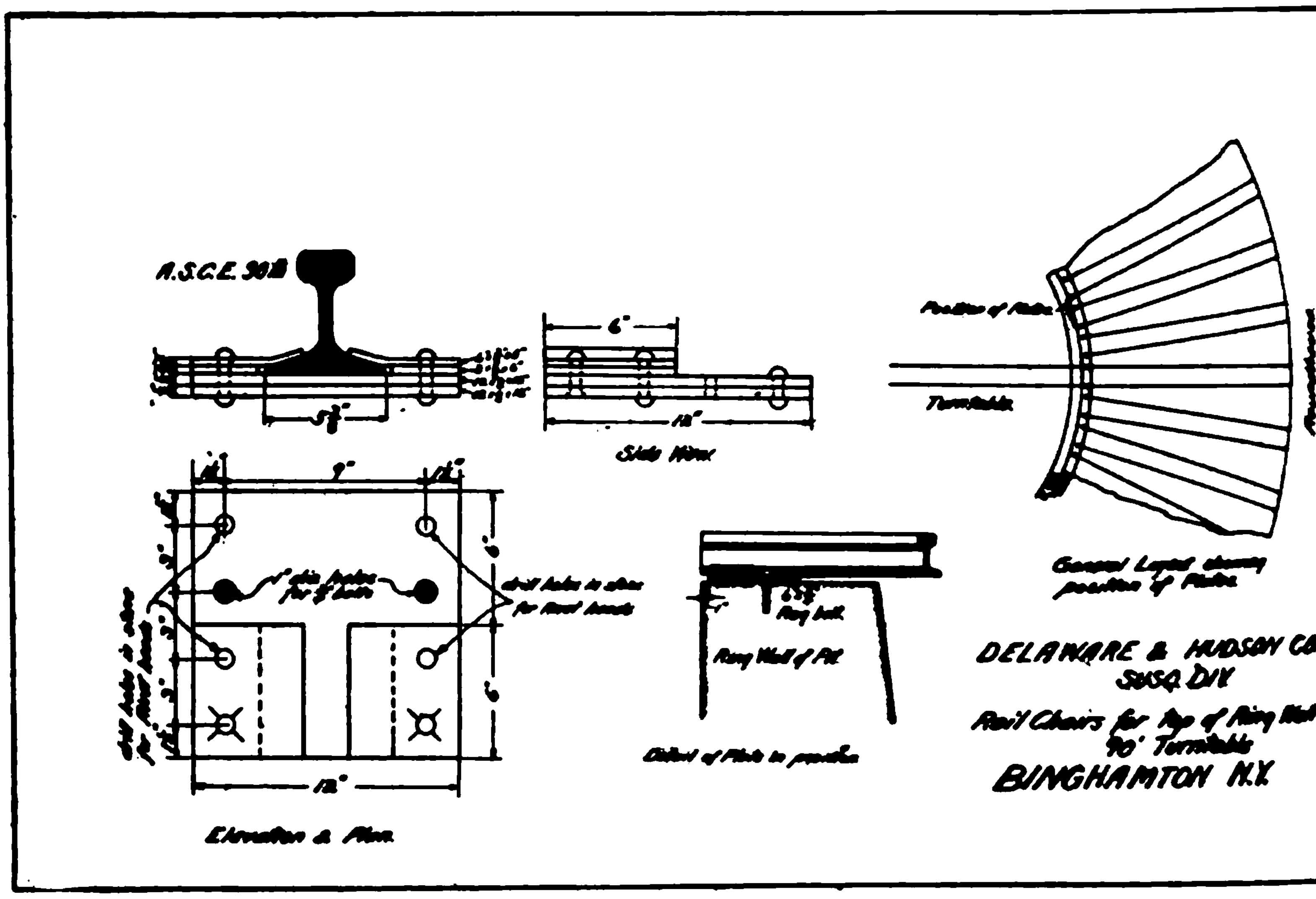
D L. & W.—The approach and circle rails rest directly on the concrete circle wall and are held by anchor bolts. The parapet wall under the approach rails are reinforced by the two curved rails embedded upright in the concrete

Section of Circular Wall of Concrete
Pit for 80 ft. Turntable
C.R.R. Co. of N.J.

Connections of Rails to Center Wall, Central R. R. of New Jersey.



Connections of Rails to Circle Wall, Cleveland, Cincinnati, Chicago & St. Louis Ry.



Connections of Rails to Circle Wall, Delaware & Hudson Co.

E. J. & E.:—The approach and circle rails rest on concrete anchored down by bolts set in drilled holes.

I. & G. N.:—The flanges of the approach rails are notched for spikes for 30 ft. from the circle wall to prevent creeping.

Maine Central:—The rails are held to the circle wall by cast iron clips and bolts.

N. C. & St. L.:—The approach and circle rails are attached directly to the concrete by steel clips and bolts.

Nat. Rys. of Mex.:—The rails are attached to the timber coping and ties or to cast iron chairs.

N. Y. C. & H. R.:—The rim of the circle wall is surmounted bv an 8 ft. 48 lb. Bethlehem beam bent to a circle and bolted down. The approach rail is bolted down. It formerly rested on two curved rails embedded in concrete. The circle rail rests on short ties in some cases, on concrete in others.

P. & R.:—The approach rails are spiked to coping timber. The circle rail rests on cast iron chairs, and is held down by clips and bolts on the concrete wall.

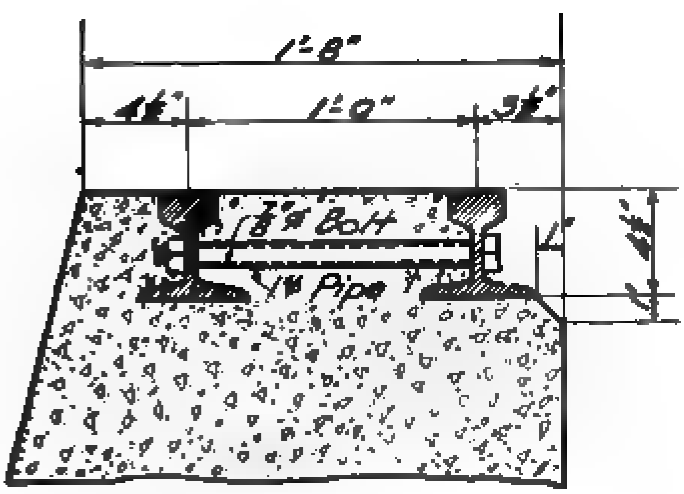
S. L. & S. F.:—The approach rails are spiked to the timber coping. The circle rail rests on and is partly embedded in concrete.

U. P.:—The approach rails are spiked to the timber coping. The circle rail is embedded in concrete with about ½ in. of head protruding.

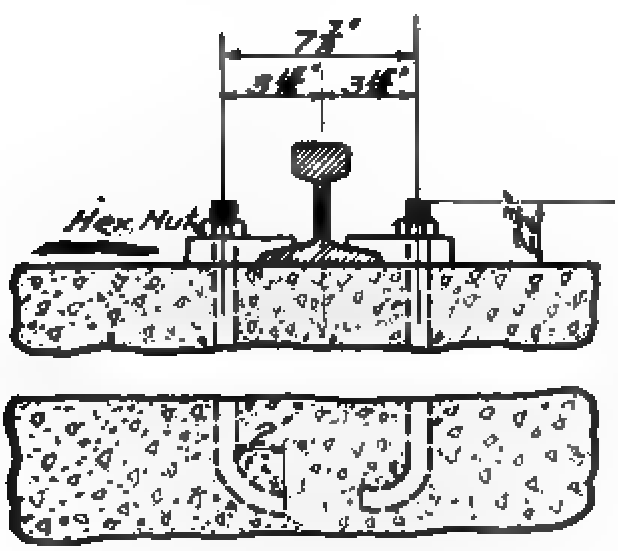
Much trouble has been reported as the result of resting the rails directly on the concrete, especially under the main approach tracks and the above detailed description of the methods of reinforcing at such places shows the extent to which many engineers consider it necessary to go to avoid the trouble. Even where such rigid supports are provided there will probably be broken rails and other objectionable conditions resulting from the rigidity of the support, and it would appear that a timber cushion would be very desirable.

The Committee recommends providing a support for the ends of the approach rails on creosoted coping timbers, not less than 12 in. wide at the narrowest point, and preferably 8 in. thick, with two heavy standard tie plates under the end of each rail, where the rails are spaced so as to permit

Tracks



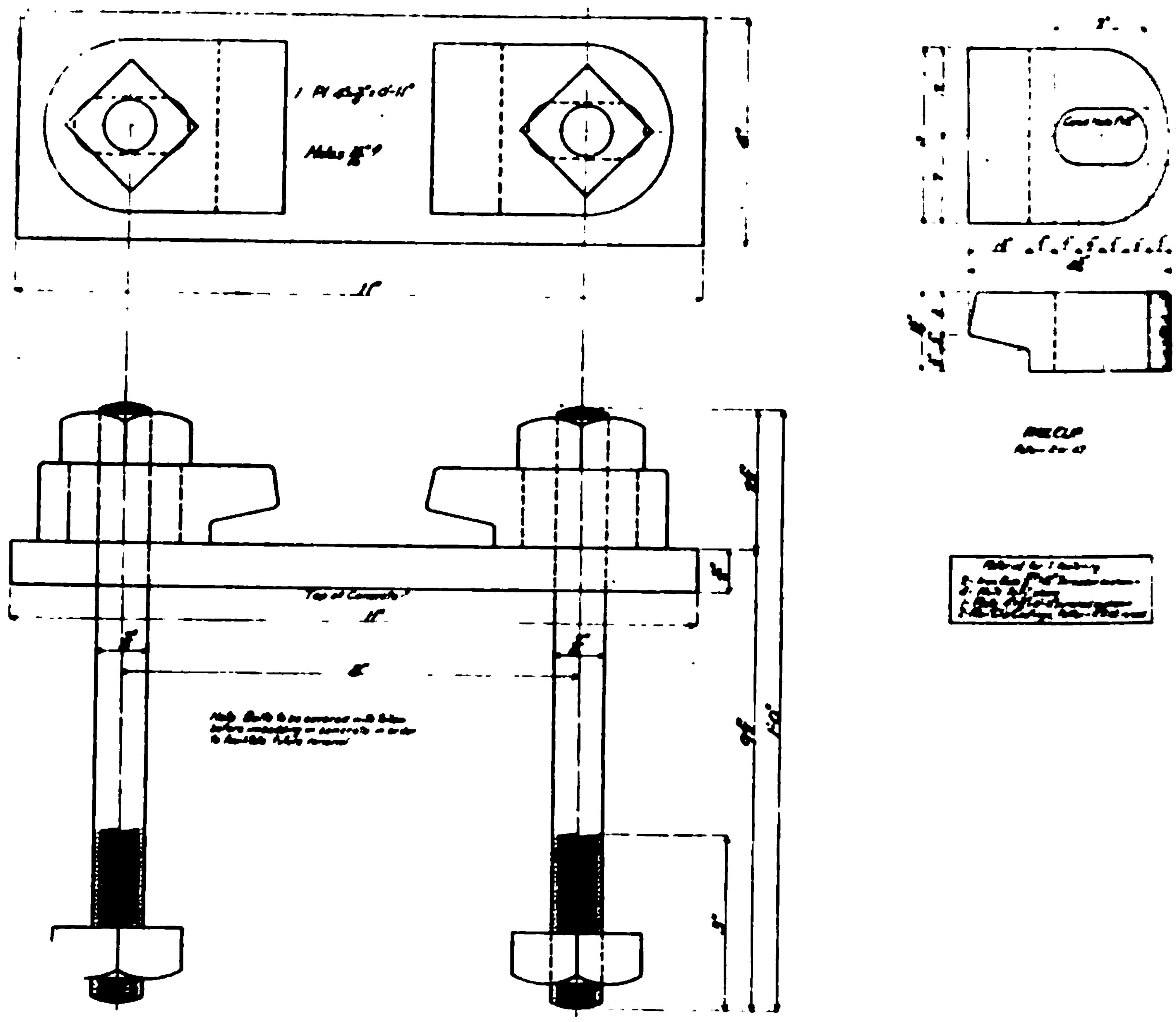
DETAIL AT A



DETAIL AT B

Anchor Bolts to be set when Concrete is being put in place.

Connections of Rails to Circle Wall, D. L. & W. Ry.



Connections of Rails to Circle Wall, N. C. & St. L. Ry.

this, or a special plate not less than one in. thick, 12 in. wide and long enough to pass under the two near rails of adjacent tracks, the plates to be drilled for track spikes or screw spikes and for lag screws for attaching them to the coping timber. The coping timber should be attached to the concrete by anchor bolts.

The Committee also recommends providing support for the circle rail by short creosoted ties about 15 in. center to center under main tracks and 24 in. elsewhere, with tie plates and screw spikes where available. To hold these ties in position and to prevent the accumulation of dirt, cinders, rubbish, etc., the space between them and between their outer ends and the parapet wall should be filled with concrete sloped to drain under the circle rail to the pit.

Although cut stone was universally used for circle walls in the past and many walls of such material are still in service, it is customary at present to build the circles of concrete except at such points as timber walls are used to effect economy or for temporary installations.

Where timber walls are used over hardpan or rock, blocking can be used but extreme care must be taken in placing the blocking to break joints and in drifting the timber together to keep the wall from crowding forward. Where the foundation is not firm enough for blocking, piles should be driven as long as possible to refusal, spaced about 3 ft. to 4 ft. center to center. Timber walls have been built and can be built in such a manner that they will be entirely satisfactory. On the other hand they have been built in such a manner that they have caused endless trouble. The greatest care should be taken in the construction of a timber wall.

Where a concrete circle wall is used the greatest care must be taken to secure a sound foundation for the wall and for the circle rail in order to

avoid settlement. To accomplish the desired result the footing should be extended to hard pan of rock or supported on piles driven to refusal. The piles should be placed directly under the parapet and circle rail. Great care must be taken in placing the bearings of the approach rails and in placing the circle rail to get a perfect level in each case. Some roads make the cross-section of the circle wall equal to that of a gravity abutment but this is not necessary if a complete circle be constructed as the arch effect permits the use of a considerably lighter wall.

It is of great convenience to have a recess in the parapet wall at some point and a concrete pit, constructed around the recess forming a so-called repair pit, through which ready access may be gained to the end of the table.

Paving of Pits.

Practically all railroads report the use of concrete or brick paving for turntable pits in standard installations at the most important points, concrete having the preference, but the majority of the roads also report many pits with no paving, the floor of the pit being finished with earth, cinders or gravel. There is no doubt that concrete or brick paving gives a much better appearing pit, but there is a question whether or not the expense is justified. The cost of paving, according to many of the plans submitted, will be close to $1,000. A porous layer of cinders or gravel 6 in. to 12 in. thick, will absorb all water and oil that runs into the pit and will prevent the occurrence of mud. The growth of vegetation should be very easy to stop. Mr. F. G. Jonah expresses his opinion on this subject as follows: "I think the bottom of all turntable pits should be paved. If they are not paved the rainfall in most sections of the country will wash away the cinders and stop up the drains, and will gully up an earth bottom if it is left that way."

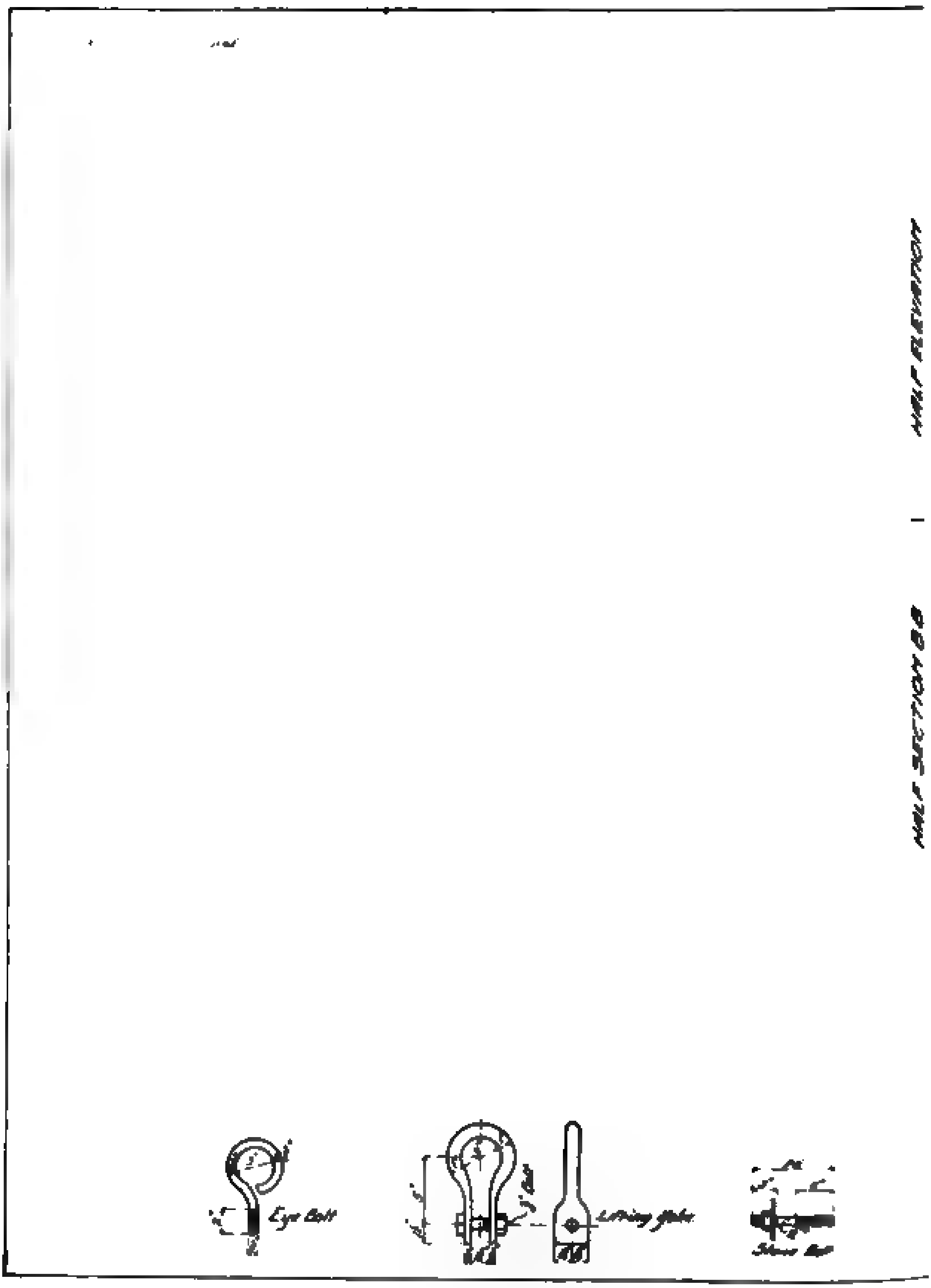
Cost.

Cost figures of turntable installations are of very little value, as the cost is affected by so many conditions, such as locality, condition of market for material and labor, congestion at busy terminals compared with isolation at unimportant points, the detailed procedure that must be followed, the time within which the work must be completed, drainage and other factors. The turntable is such an important adjunct that attention should be given to good design rather than to keeping the cost low. In a very general way, however, it may be stated that average costs of turntables, complete, installed with tractor, may be taken as follows:

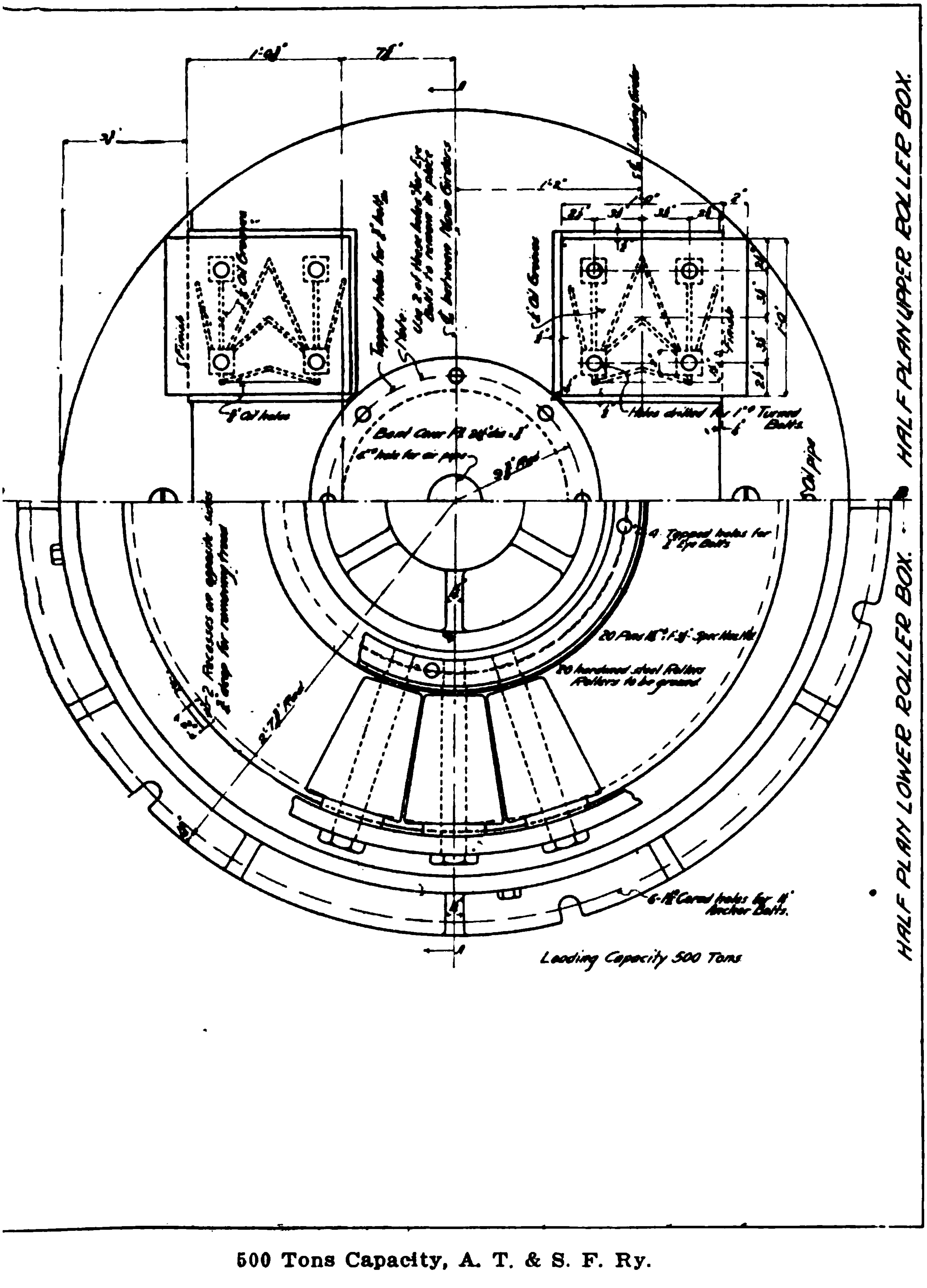
Deck tables, 75 ft.	$7,500
Deck tables, 80 ft.	8,000
Deck tables, 85 ft.	8,750
Deck tables, 90 ft.	9,500
Through tables, 85 ft.	11.500
Through tables, 100 ft.	15,000

The following figures were furnished by a number of roads:

A. T. & S. F.	85 ft. table, through	$11,000
	130 ft. table, designed for handling largest Mallet	20,000
B. & O.	80 ft. table,	7,500
B. & L. E.	80 ft. table,	8,500
B. & A.	85 ft. table, between 8,500 and	9,500
C. of Ga.	80 ft. table,	5,100
C. R. R. of N. J.	80 ft. table,	8,277
C. & O.	85 ft. table,	8,000
	100 ft table,	10,000
C. & N. W.	80 ft. table,	4,800
C. G. W.	90 ft. table,	10,760



Standard Turntable Center.



500 Tons Capacity, A. T. & S. F. Ry.

C. M. & P. S.	85 ft.	table, deck,	$ 10,630
		table, through,	12,430
		table, half through	10,900
C. R. I. & P.	75 ft.	table,	7,500
	90 ft.	table,	9,000
C. St. P. M. & O.	80 ft.	table,	4,720
C. C. C. & St. L.	85 ft.	table,	9,000
C. & S.	80 ft.	table,	5,800
D. & H.	90 ft.	table,	9,850
E. J. & E.	80 ft.	table,	6,500
Erie	80 ft.	table,	8,500
Grand Trunk	80 ft.	table,	6 000
Great Northern	80 ft.	table,	7,900
	92 ft.	table,	9,700
Illinois Central	85 ft.	table,	8,850
	75 ft.	table,	6,750
I. R. of C.	75 ft.	table,	7,700
I. & G. N.	75 ft.	table,	6,000
K. C. S.	90 ft.	table,	9,500
L. S. & M. S.	85 ft.	table, $6,500 to	8,000
L. V.	80 ft.	table,	8,700
Long Island	80 ft.	table,	4,980
Maine Central	80 ft.	table,	8,300
Mo. Pac.	75 ft.	table,	6,000
M. & O.	75 ft.	table,	5,750
N. C. & St. L.	90 ft.	table,	8,825
Nat. Rys. of Mex.	75 ft.	table,	8,100
	80 ft.	table,	9,000
N. Y. C. & H. R.	80 ft.	table,	11,000
N. Y. N. H. & H.	75 ft.	table, deck type,	7,800
		table, through type,	10.300
N. & W.	100 ft.	table, alone,	5,000
		Pits vary from 5,000 to	10,000
		Total, 10,000 to	15,000
O. S. L.	66 ft.	table, to 100 ft. in length have varied from 6,000 to	25,000
O. W. R. & N.	80 ft.	table,	8,000
Frisco	75 ft.	table,	6,500
S. A. L.	85 ft.	table,	9,000
Wabash	75 ft.	table,	7,550

CENTERS.

The center is the heart of a turntable. When that is out of business the turntable is out of service. The difference in cost between a very poor center and the very best center is so slight compared to the importance of avoiding trouble that the best centers available should be used.

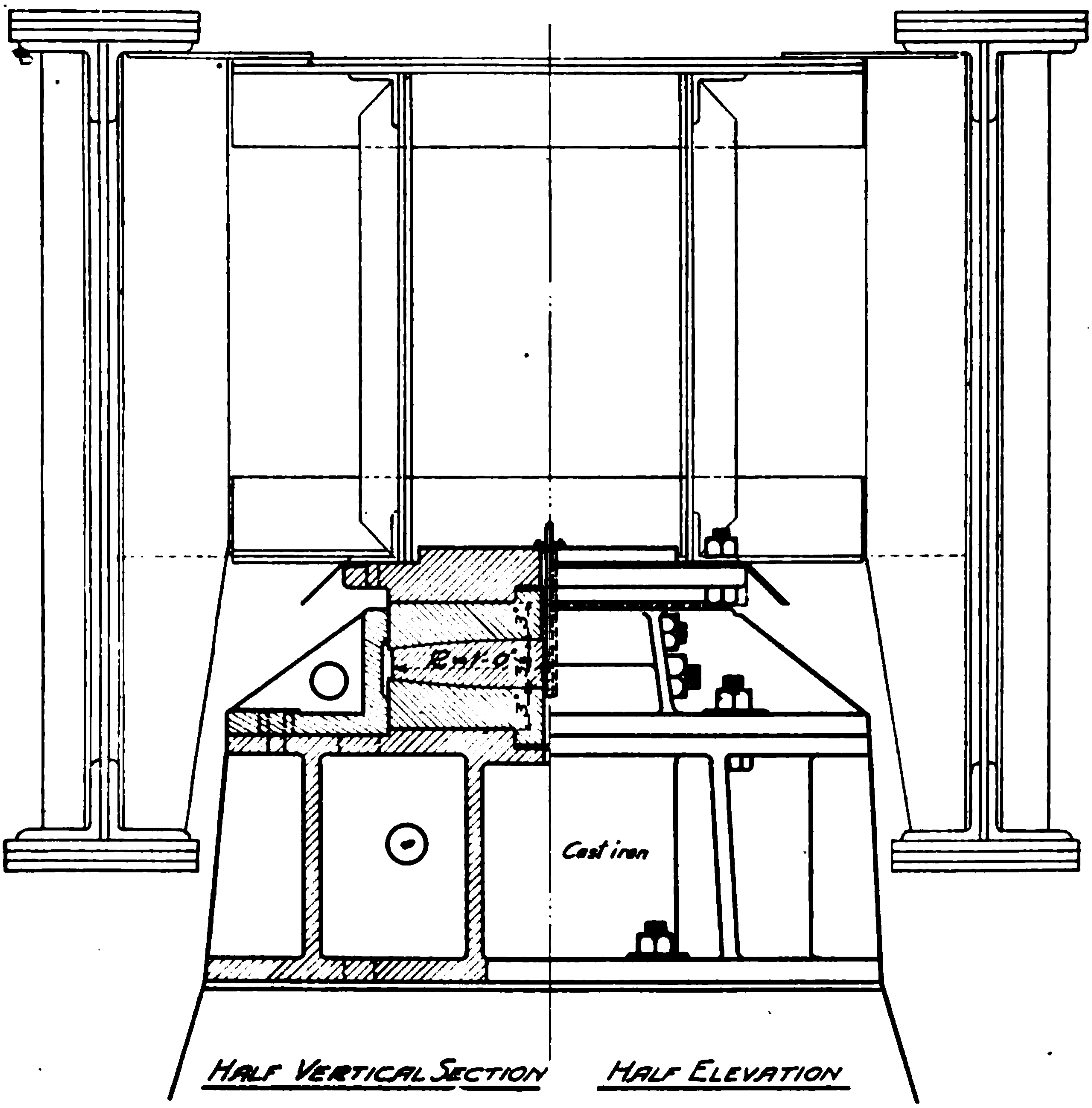
Forty-six roads reported the use of manufacturers' standards of conical roller bearing centers, some with ball bearings or phosphor bronse discs at the ends of the rollers to reduce friction, and others depending on the cast top and bottom sections holding theirs in position.

The roads using other than the above and the information furnished by them are given below:

A. T. & S. F.:—We have always used our own standard centers. While disc bearings work very well, the writer never succeeded in getting one that gave prospects of long life and easy turning.

B. & M.:—Disc centers.

C. R. R. of N. J.:—Our standard practice at the present time is to use a conical roller bearing center with a spider for keeping the rollers in their true position. It was found that rollers without the spider have a tendency to crowd out of position and line, causing the table to turn very hard under heavy loads. This is especially noticeable if the center of this type has



Disc Center for 80-ft. Deck Turntable, C. B. & Q. R. R.

been in service a year or so and the conical rollers have become somewhat worn.

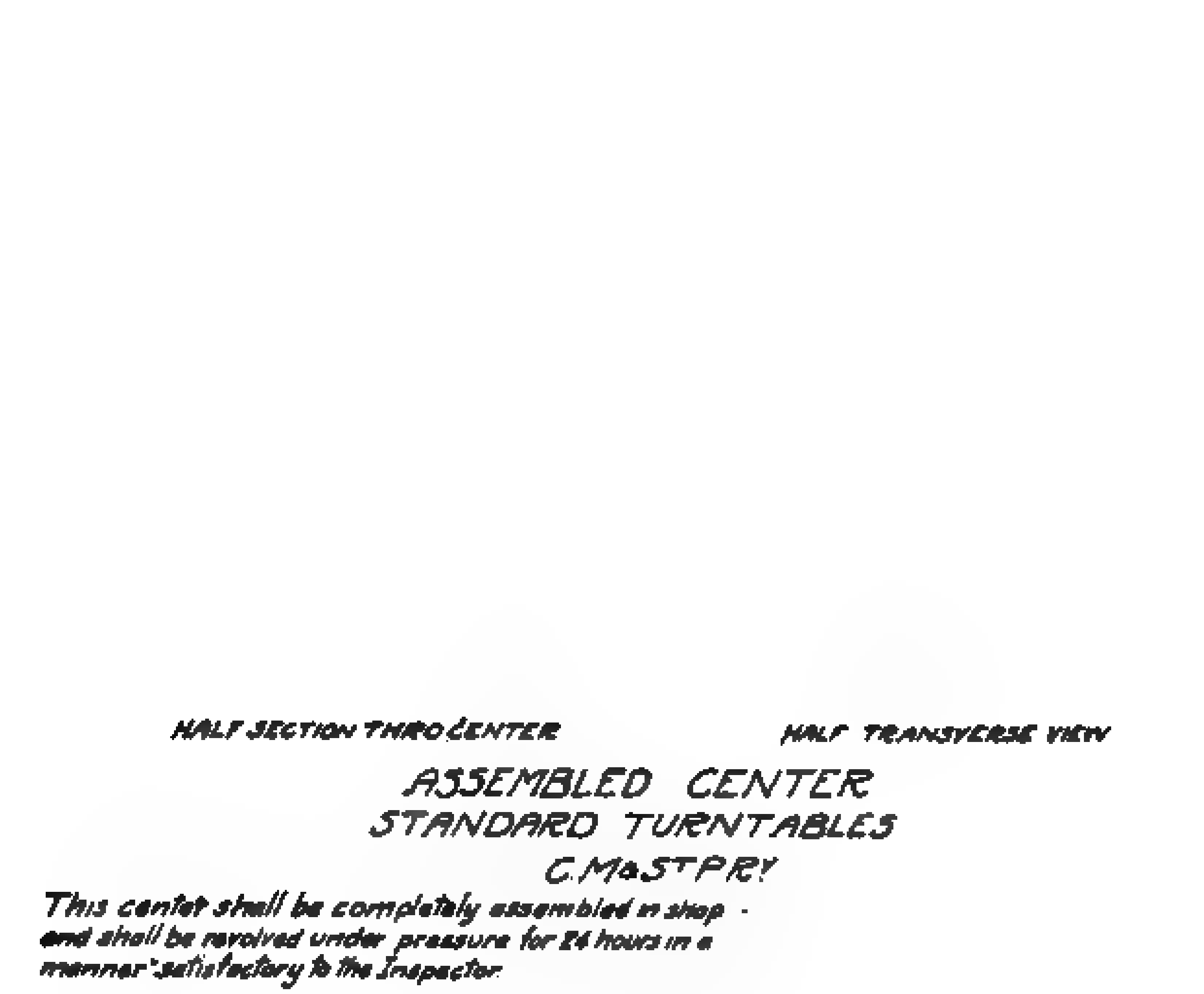
C. & N. W.:—Our experience with disc bearing centers has been that they operate very well with small turntables handling light power. Turntables handling very heavy power operate more satisfactorily with conical roller bearing centers.

C. B. & Q.:—We have used trade standards as a rule but are now designing our own. Conical roller bearings will not stand up under heavy power. We have had disc bearing centers in use three years and they are so far entirely satisfactory.

C. M. & P. S.:—We use a special standard conical roller bearing center with ball bearings. We have tried only one disc bearing center which was not at all satisfactory and had to be removed.

C. M. & St. P.:—We use our own design of center which has conical rollers with ball bearing ends. It cost about $1,000. We have had some experience with disc centers which were not satisfactory.

C. C. C. & St. L.:—Disc centers are standard. We have used trade standards in tables less than 85 ft. long. Our experience with disc centers has not been extensive but we are convinced that the advantages in maintenance will more than offset the slightly greater power required to turn. The



Cross-section of Standard Turntable, 325 Tons Capacity, C. M. & St. P. Ry.

conical roller bearing as ordinarily designed is entirely too small for the loads carried and the cost of maintenance is excessive.

Erie:—We use conical roller bearing centers with ball bearings at the ends of the rollers. With heavy power we have experienced trouble with the balls and have substituted discs for the balls at the ends of the rollers.

I. Ry. of Can.:—We use ball bearing centers. We have had some good conical roller bearings and some that failed by flattening.

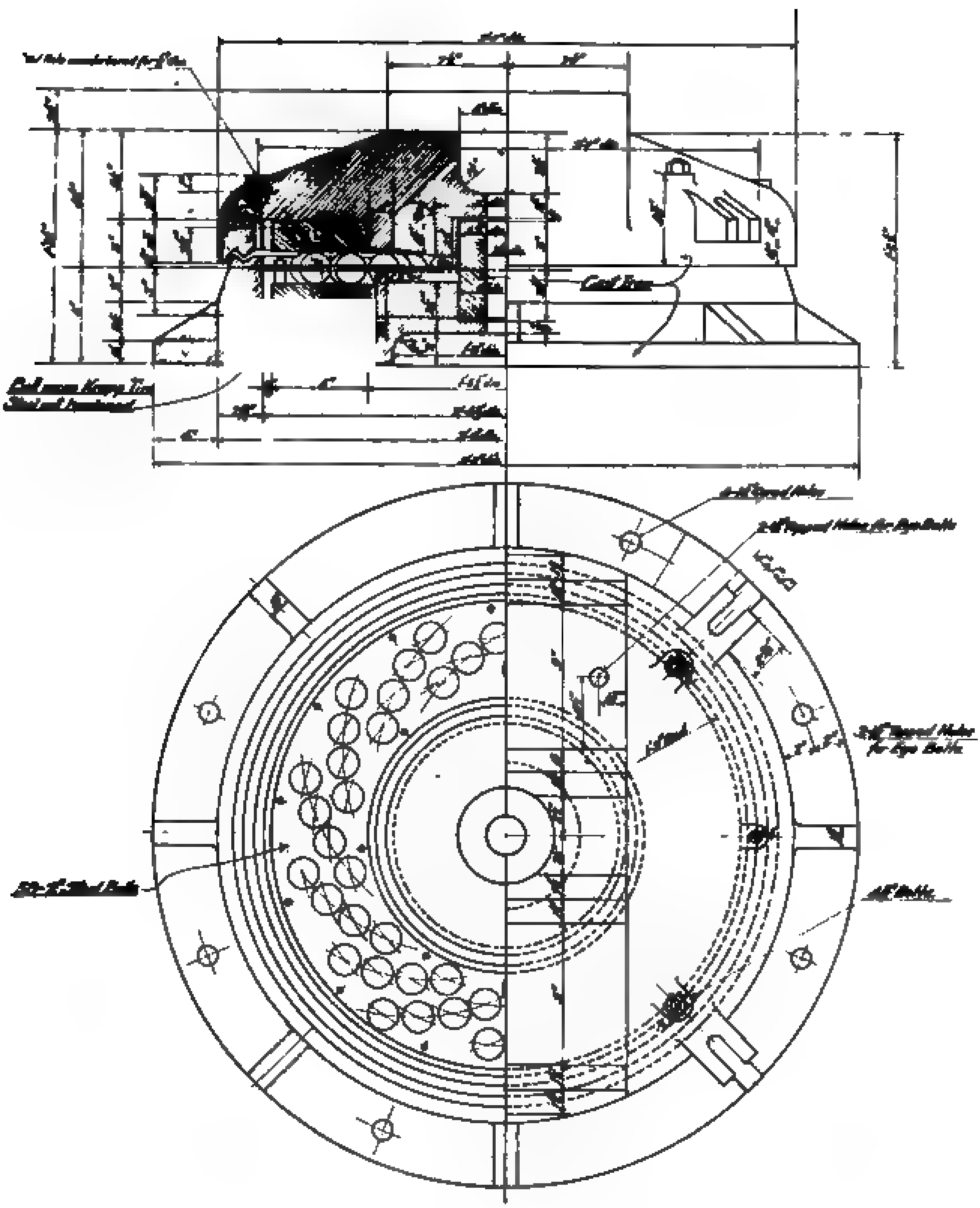
Lehigh Valley.:—We use conical rollers with a live ring. All conical rollers are provided with independent bearings. Disc bearings for modern turntables and loadings are not satisfactory on account of the heavy pressure preventing proper lubrication.

M. C.:—We use disc centers according to N. Y. C. standard.

N. Y. C. & H. R.:—We use disc centers.

It will be noticed that both disc centers and conical roller centers have their adherents, the Boston and Maine, Maine Central, Chicago, Burlington and Quincy, Cleveland, Cincinnati, Chicago and St. Louis and New York Central & Hudson River reporting the use of disc centers. The Intercolonial Railway of Canada reports the use of ball bearing centers in which hardened steel balls two inches in diameter roll between the top and bottom castings. The latter has been used under short tables of light capacity; it would probably be impossible to get a satisfactory center of such design for modern heavy loads.

The conical roller centers appear to be satisfactory if properly designed, costructed and maintained. Improper attention to these features has caused much trouble and much criticism of this type of center. One of the principal faults with the design of former conical roller centers was the small length of the rollers which created unit pressures greater than they should have been. This resulted in the wearing and flattening of the rollers and in the



BALL BEARING CENTER FOR 60 FT. TURNTABLE

wearing of the rollers into the surfaces of the top and bottom castings. The conditions could be improved by planing the castings but the trouble usually resulted in the renewal of the rollers and of the castings, practically the entire center, which was expensive. In later designs the length of the rollers was increased and track plates were attached to the top and bottom castings so that in case of wear the track plates and not the entire castings are renewed. The rollers and track plates should be of hardened steel and the castings of steel.

In the earlier designs of conical roller centers no means was provided for keeping the rollers a constant distance from the center although there is a tendency for them to crowd out or to work in on radial lines. Their working in, which seldom took place, resulted in their rubbing on one another with consequent increase in difficulty of turning. Their crowding out resulted in the top and bottom castings coming together and rubbing and in the outer ends of the rollers working against the rough inner surface of the castings with the consequent damage to rollers and castings and increase in difficulty of turning.

In later designs, and more particularly for the heavier tables, means are provided for holding the rollers in line. Some makers do this by placing the rollers in a depression of the bottom casting, the casting being raised at the outer ends of the rollers to make contact with their ends and rubbing takes place here during turning. If the rollers are of steel and the casting also of steel as should be the case, cutting may result if there is any tendency for the rollers to crowd out. The most approved practice consists in the placing of a steel ring, called a live ring, around the rollers, set screws or lugs projecting from the end of each roller or bolts passing entirely through the length of the rollers and through the live ring; this ring answers the double purpose of keeping the rollers from crowding out and keeps them the proper distance apart. In some designs, especially where bolts pass through the rollers, rings are provided in a similar manner for the inner ends of the rollers, which with the bolts, form a spider.

If the rollers work in or out against the live rings the rubbing causes friction that cuts into the metal and increases the difficulty of turning. To overcome this, phosphor bronze frictionless washers, or ball bearings are provided in many designs between the ends of the rollers and the live ring.

Conical roller centers without separate track plates or live rings are doing excellent service at many points, and trouble has been encountered in many cases with centers having the above mentioned improvements. As a general rule, however, for heavy tables that will be subjected to frequent service, every possible effort should be made in the design, construction and maintenance to reduce friction to a minimum, by the use of the above improvements.

The best practice in drawbridge design favors the use of disc centers under the largest draw spans and that type of center is carrying successfully spans weighing in excess of 1,000 tons. In view of this it seems very odd that an overwhelming majority of the roads favor conical roller centers for turntables and many engineers replying to the Committee's circular stated that disc centers will not stand up under heavy turntable loads.

On the other hand several roads have had very successful results with disc centers as mentioned above. In reply to special letter of inquiry the Chicago, Burlington and Quincy Railroad reported: "We have had a through turntable in operation at Kansas City with one of these centers for several years and it has proven entirely satisfactory. This is a very busy point and the heaviest engines we have except the Mallets are turned on this table. We have just installed at Galesburg the first disc center under a deck table. This is also a busy point where the table is handled by a tractor. They advise that with the new center they use only one-half of the men we used with the old conical rollers. This center at Galesburg was made by the Vulcan Iron Works and cost us $427 for the center and $69 for the pattern. I am surprised to know that other companies have had better success with the conical roller centers. I do not know of a single center of this type on our

DISC CENTER
MISSOURI PACIFIC RAILWAY
1000 TON DRAWBRIDGE
(Shown here for comparison with Turntable centers)

lines under constant heavy service that does not make trouble while the disc centers so far installed have been entirely satisfactory."

A Committee of the New York Central Lines which investigated the matter of centers recommended the use of disc centers and they are standard on those lines.

The oiling of the moving parts of the center whether rollers, balls or discs is very important. The bottom casting should be so designed that the rollers, discs or balls can move in a bath of oil, and the top casting so designed that cinders, dirt or other grit can not get inside. A mixture of black oil and signal oil is excellent for the lubrication of centers. They should be flushed out frequently by kerosene or gasoline, and should be taken apart and cleaned whenever they begin to turn hard.

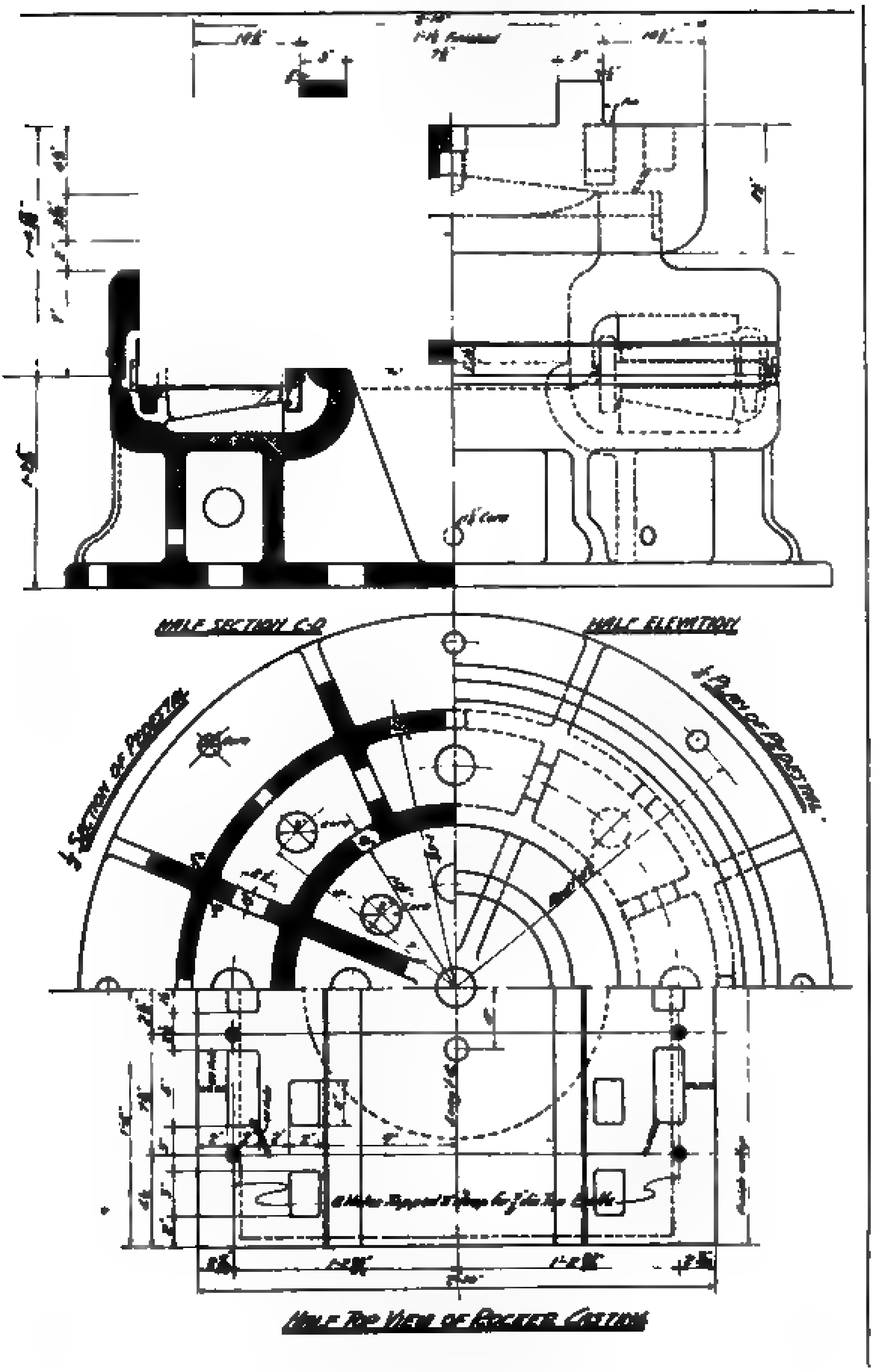
The illustrations accompanying this report show the distinguishing features of a number of the best turntable centers.

While the Committee does not feel itself justified in recommending disc centers, in the face of the extended use of the roller bearing centers, which in many cases are satisfactory, it does recommend that properly designed disc centers be given serious consideration.

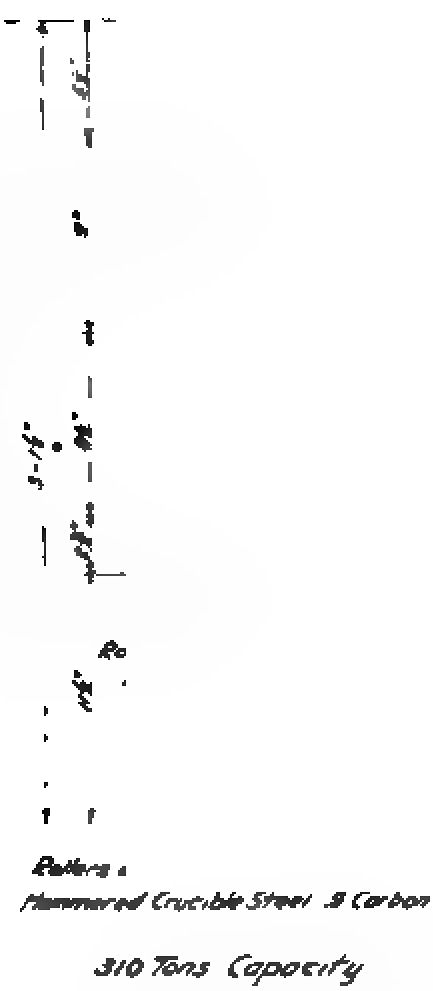
Frogs in Approach Tracks.

About 50 roads report that frogs are not used in their standard lay-outs, but are used in special cases where new tables are installed in old lay-outs. About ten roads report using frogs in their standard lay-outs, usually for the purpose of getting more stalls in a complete circle. The Committee recommends that the use of frogs in approach tracks be avoided where possible to avoid them and that standard lay-outs be prepared with that object in view.

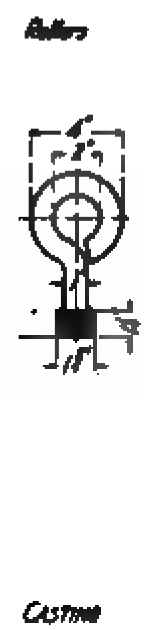
Standard Turntable Center.



American Bridge Company.

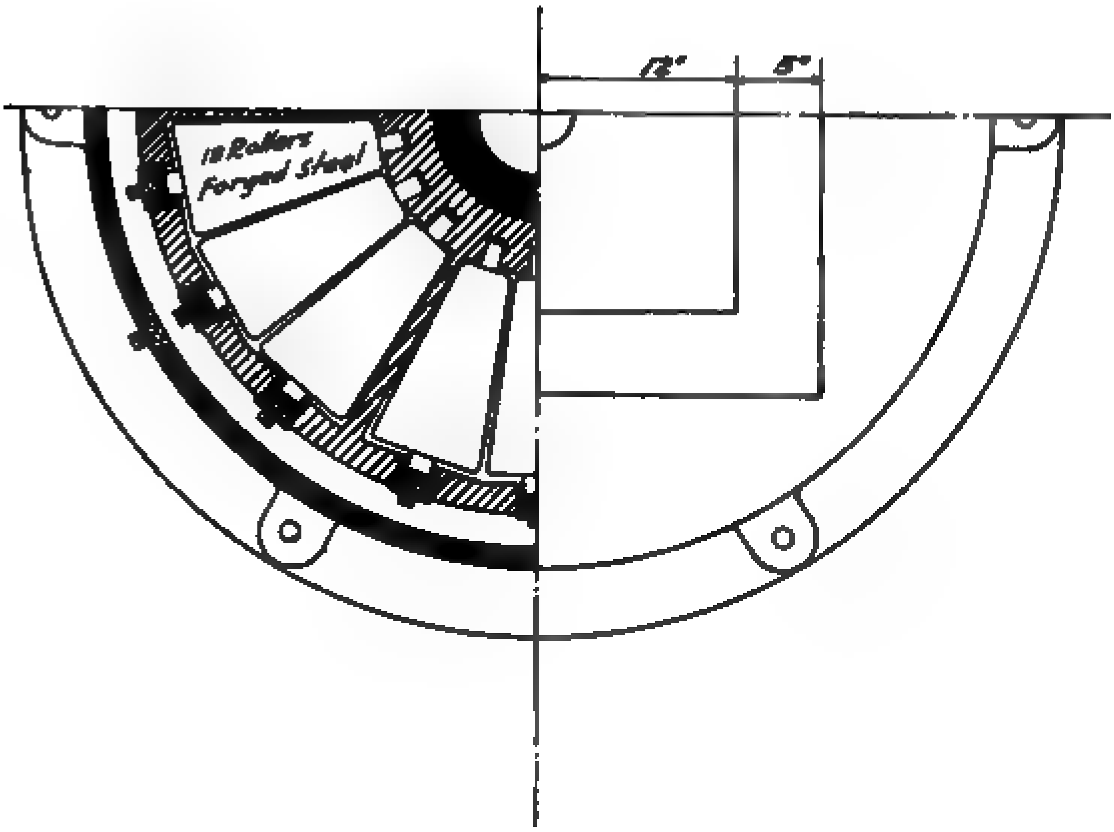


Standard Turntable Center, 310 Tons Capacity, Pennsylvania R. R.



Standard 200-Ton Turntable Center, Philadelphia Turntable Co

Standard 325-Ton Turntable Center, Philadelphia Turntable Co.



Standard 375-Ton Turntable Center, Philadelphia Turntable Co.

Standard Roller Centers for 85 ft. and 90 ft. 300-Ton Turntable, 105 ft. 325-Ton Turntable, Chicago, Milwaukee & St. Paul Ry.

OTHER MEANS OF TURNING.

All the roads report the use of wyes where convenient for turning engines, but tables are invariably used for getting to roundhouses. There are a few exceptions; for example, the Great Northern reports: "At Judith shops, Montana, we have an eleven stall rectangular engine house, seven stalls on one side and four on the other and a track arrangement providing a turnout to each stall with a wye for turning."

The Santa Fe reports: "On our Eastern Railway of New Mexico where we have three 90 ft. tables in service we are using what is known as the double Prairie Mallet engine. A pair of short outriggers are fastened to the rails at one end of the table and this allows the rear wheels of the tender to run beyond the end of the rail, perhaps ten or 15 inches. For the other Mallet engines, that is, the double consolidation or freight Mallet and the double Santa Fe Mallet, we have not provided any tables, but are turning the engines on wyes. We generally arrange the roundhouses so that we can get five or six stalls which can be used by the Mallet engines without having to swing the table, the turning of the engine being done with the wye."

MAINTENANCE.

The maintenance of turntables may be easy or hard according to conditions. If proper care is used in the design and construction, the maintenance should not be difficult although it will necessitate frequent inspection and immediate correction of any defects that may be discovered. Constant war must be waged against the elements that tend to corrode the table and the Committee knows no other means of preventing corrosion than frequent cleaning and painting, patch painting when necessary. At least once each year and as much oftener as centers are submerged by floods or turn hard for any reason, the table should be jacked up and the center thoroughly cleaned and re-filled with oil. To facilitate this jacking many roads provide steel brackets riveted to the table and concrete foundation for the jacks on one diameter of the pit.

C. E. SMITH,
C. H. FAKE,
F. G. JONAH,
J. S. BERRY,
A. S. MARKLEY,

Committee.

TABULATION OF PRACTICE OF VARIOUS RAILROADS WITH REFERENCE TO TURNTABLES.

NAME OF ROAD	LENGTH OF STANDARD	TYPE	LOADING AND UNIT STRESSES	LOCKS for HOLDING RAILS IN LINE	POWER FOR TURNING.	MEANS TO FASTEN RAILS to PARAPET the CIRCLE WALL	APPROXIMATE COST	CENTERS
A.T. & S.F. System. 10,204 Miles A.F. Robinson Bridge Engr.	85 ft. A few built 90 ft. to avoid the use of frogs. In 1896 we commenced building 60 ft. Tables. We used these about 2 years and then went to 75 ft. The 75 ft. lgth lasted less than 1 year when the new engines forced us up to 85 ft. Tables.	Through tables entirely as they give the shallowest pit. Nearly all of our tables are located relatively close to the high water elevation and as a result shallow pits are desired. We have not built any deck tables in the last 16 years.	Our tables have been designed for the heaviest engines we have on the road. 60 ft. table, 135 ton engines. 75 ft. table consolidated engine with 200,000 lbs. on drivers and also Mikado engine. Our latest 85 ft. table was designed for our heaviest 3-[illegible] type engines which [illegible] 249 tons, base [illegible] 77-10". [illegible] tension and [illegible] gross shear [illegible] plates [illegible] never less than [illegible] Use low unit stresses in order to keep the deflection as small as possible.	Forging in the shape of the letter "I". This slips in between the webs of the rail on the table and in the approach tracks.	Twelve years ago we adopted an appropriation of $300 with which to experiment with turn table tractors. Shortly after we placed an order for 20 Tetlow motors and later 5 or 6 more. These air motors will work satisfactorily if proper care is exercised in the arrangement of the drainage to prevent freezing. The motor is not fool-proof, but it has given good service on our lines. As the power on the system increased in weight and as we installed electric power plants at our machine shops we gradually went into the use of electric motors. At the present time all of the above air motors are in service and about 25 electric motors.	The rails in radial tracks are spiked to a timber wall on top of the circle wall. The circle rail in the pit is laid on sawed ties which rest on concrete and the rail is spiked to these ties.	The standard 85 ft. table, equipped with electric motor will cost close to $11,000 ready for use. Motor $1,400, substructure $3,500. A table designed for handling our larger Mallet engines, balancing the load when turning, would have to have a pit from 125 ft. to 130 ft. in diameter. This table would cost as much as $20,000, complete ready for service.	We have always used our own standard centers while disc bearings work [illegible] well the writer never succeeded in getting out one that gave prospect of long life and easy turning.
Baltimore & Ohio System. 4,724 Miles F.L. Stuart, Ch. Engr.	80 ft. turntable with end carriage for ordinary road engines of the Pacific or Mikado type. At points where it is necessary to turn Mallet engines we are using 100 ft. table with end carriages.	No through tables. All of our tables are so located that pits for deck tables can be properly drained.	Our more recent 80 ft. tables are being designed for Mikado engines weighing 275 [illegible] and the [illegible] tables we [illegible] [illegible] center [illegible] [illegible] are being designed for [illegible] Mallet engines. Unit strains for flanges 20 [illegible] per sq. in. Shear 6326 lbs. sq. in.	None	Where electric power is	Approach rails spiked	Our standard 80 ft. [illegible] neighborhood of $7,500.	With the heavier loads occasioned by the turning of Mallet engines, we consider centers with conical rollers the best type. This is primarily due to the fact that the radius of the bearing area of a conical roller center is larger than would be provided by a disc center and the shifting of the center of gravity of the load, due to the tipping of the tables, has less effect on the bearings.
Bessemer & Lake Erie Railroad. H.T. Porter, Ch. Engr. 269 Miles.	80 ft.	All deck girders.	Cooper's E 60 loading. Stresses according to specifications of the American Railway Engineering Association.	Slotted casting on	Three of our tables	Approach rails bear on a [illegible] plate resting on timber top of parapet wall [illegible] [illegible] [illegible] [illegible] approach rails and pit rails down. Pit rail rests on 7" x 9" ties laid flat and [illegible] in Parapet timber and ties supported by concrete circle wall 6'-7" inside on [illegible] [illegible] or 9'-6" wide on [illegible].	80 ft. table complete as follows: Excavation and foundation $3,000. Table with [illegible] $3,000. [illegible] ties & [illegible] $900. [illegible] rail & fittings $500. 20 H.P. elec. tractor $1,500. Miscellaneous $300. Total $8,600.	All conical roller centers. Latest type Am. Bridge Company standard.
Boston & Maine R.R. 2,281 Miles A.B. Corthell, Ch. Engr.	75 ft. but are considering 80 ft. standard. Sometimes we add length to accommodate frogs in approach tracks.	Deck girders	Cooper's E-60, stresses according to specifications of the Am. Ry. Eng. Association.	2" x 3" plank shod with iron at ends to slide between webs of rails at ends of turn tables.	We use power at all [illegible] [illegible] current can be obtained.	Approach rails on timber coping. Circle rails on ties. Coping and ties on concrete circle wall. In some new installations rails rest on steel plates on concrete and are held down by anchor bolts and clips.	No reply.	Disc Centers

Albany RR. 392 Miles. W. F. Steffens, Engr. Structures		... as ... has not been limited by drainage conditions.	as Cooper's E-60 but with pole spacing increased ... total of 10 ft. to get greater bearing moment at center.	... reply. Power. In a number of installations we have ... motors of the ... type generally used for turntables. At some isolated places, where not convenient for electric motors, nor economical to install gasoline motors, we use air motors of the type made by the Pilling Co.	We use wherever ... electric motors, as this is an ideal form of ...	Edge of circle formed by ... [illegible] concrete ... rails ... Circle rail rests on ... plates ... bolts set in concrete ... Conc. circle wall ... base rests on 2 rows of piles 3' c. to c. ... where nec'y. In some cases where the installation is likely to be changed we have used timber circle wall.	85' Tables ... about ... in place. Complete installation in place of old table ... [illegible]	Heavy type of ... [illegible] ... 10" long.
Buffalo Rochester & Pittsburgh Ry. 568 Miles. E. F. Robinson, Ch. Engr.	65'-70'-75'-80'. We have no ... [illegible] ... engines. Now putting in 90 ft. tables.	Deck Girders	Cooper's E-60 16,000 lbs. sq. in. in tension, 10,000 lbs. in shear.	Sliding "T" bars engaging ends of spider rails.	Electric tractors	Rails are secured by bolts and bevel washers to channel irons set in concrete coping in later designs.	No reply.	Conical roller bearings used entirely and have always given satisfaction.
Central of Georgia Ry. 1915 Miles. C. K. Lawrence, Ch. Engr.	80 ft.	Deck plate girders only have been used. Should drainage conditions require it we would use thru plate girders.	Cooper's E-55 Tension 8,000 $(1+\frac{Min}{Max})$ shearing pins and rivets 7,500. Pl. girder web 6,000. Bearing 15,000	Use I shaped bar at ends of table rails.	Power other than hand ... electricity is preferred.	Apch. rails rest on coping timbers on conc. ... wall. Circ. rail buried in conc. ... [illegible]	Table ... \$2,190 / 2,280 / 850 / 135 / 245 / Total ... \$5,100	Conical roller centers.
Central RR of New Jersey. 670 Miles. J. O. Osgood, Ch. Engr.	80 ft.	Deck tables wherever practicable. Thru girders have been used at tidewater where impracticable to get drainage for deck tables.	Cooper's E-55 Stress according to specifications of Am. Ry. Eng. Assn. with full impact allowance	Sliding tongue ... [illegible] ... concealed points where power is used. ... where operated by hand.	Elec. power at ... [illegible] ... most reliable.	Apch. and circular rails supported on castings on concrete circle wall. Conc. under apch. tracks reinforced ... 3 rails 12 long ... embedded ... level with top ... of conc.	8280 lbs. steel \$2,677 / Center in place ... 600 / Pit ... [illegible] / Total \$3,277. Rollers without spider ... [illegible] ... if used 2 pairs of rollers become worn.	Trade centers ... conical roller bearing C. with spider for keeping rollers in true position.
C. & O. Ry. 1938 Mi. F. I. Cabell, Ch. Engr.	70-85 ft., 100'	Deck girders. base, 16,000 lbs. ... 12,000 lbs. ... 8,000 shear ... no impact	Mat. Compound ... [illegible]	Loose toggle sliding against rail ... connected by a connecting bar.	Compressed air tractors.	Apch. rails spiked to timber ... and Circ. rail spiked to short ties embedded in conc. Both supported on conc.	85' table ... \$ 8,000. 100' ... 10,000.	Mfrs. Std. centers with conical rollers without ball bearings.
C. & A. R.R. 1216 Miles. E. L. Crugar, Asst. Ch. Engr.	90 ft.	Both deck and through girders.	Mikado type equiv. to E-60 Cooper's. 16,000 lbs. sq. in. in tension ... 8,000 ... shear	Latch consists of a hinged bar ... to table ... a socket ... to the circ.	On large tables air or electricity.	Apch. rails rest on coping timbers. Circle rail rests on ties. Both on conc. Circle rail.	No information	No standard center. Use a ... type of ... [illegible]
Chicago & Northwestern Railway. ... E. C. Carter, Ch. Engr.	All tables installed last 5 years are 80 ft. long.	Deck girders.	No standards except as obtained from manufacturers.	Latch of iron bar	14 tables air. 10 " electricity. 1 " gasolene. Electricity has proved very satisfactory, and has been put in at all points where we generate our own power.	Approach rails spiked to coping timber. Circle rail attached to ties embedded in concrete circle wall.	Steel work ... \$2,600 / Pit complete, 2,200 ... [illegible] ... bearing centers.	Trade centers. ... [illegible]

ROAD	LENGTH	TYPE	LOADING &c.	LOCKS	POWER	RAIL FASTENINGS	COST	CENTERS
C.&E.I.R.R. 966 Mi. L C Hartley Ch. Engr.	Lengths vary 65 to 75 ft. Do not have ond. tables	Mostly deck girder type. Thru girders where shallow pit desired.	200 tons	None	Air and electric power both giving good satisfaction.	Apch. rails fastened to coping timber. Circ. rail fastd. to ties in some cases and rest on steel plates in others. circle wall of concrete.	No information	Trade Centers.
C.B.&Q. R.R. 8,966 Mi. L J Hutchins Asst. Br. Engr.	70', 75', 80' deck 90' through. Lgth. made to suit class of engines turned at diff. points	Deck up to 80' lengths. Have a few thru truss tables where shallow floor is required	Trade standards for 200 ton engin. C.B.&Q. design of thru table for Mikado 426,850 lbs. Tension 16,000 lbs. sq. in. on parts not affecting deflection. 9,000 lbs. sq. in. on members affecting deflection.	None.	Gasolene power except at a few places where elec. current is available at low rates, and a few air tractors	Apch. rails rest on coping timber. Circ rail rests directly on Concrete circle wall.	No figures at hand	Trade standards as a rule. Now designing our own. Conical roller bearing will not stand up under heavy power. Disc bearings in use 3 years and so far entirely satisfactory.
C G W R R 1496 Mi. L.C. Fritch Ch. Engr.	90 ft.	Deck.	Cooper's E-55	Ordinary sliding latch	Electric tractors where current is available	Rail anchors.	Table Complete $4,960. Deck ... 400 Elec. tractor ... 900 Concrete Pit ... 4,500 Total ... $10,760	Trade centers with conical roller bearing centers.
C.I.&L.Ry. 615 Mi. A.S. Kent. Eng. M. of W.	80 ft.	Deck except where drainage is insufficient.	Mikado type, 240 tons.	None.	Expect to install electric motors at important points this season.	Rails rest on timbers embedded in concrete circle wall.	No reply.	Trade centers
C.M.&P.S. Ry. 1803 Miles. E.O. Reeder Ch. Engr.	85 ft. except in a few cases where we are now installing 105 ft. tables to take care of Mallet engs.	For 85 ft we use deck or thru depending on drainage. For 105 ft. we use pony trusses	300 tons	End latches.	In most cases turned by hand. In one or two instances use air	Apch. rails rest on coping timbers. Circle rail rests on short ties.	Three classes of construction for 85 ft. tables. First class const. assumes concrete center and circle wall. Deck $10,630. Thru $12,450. Half thru $10,900. Second class, concrete center, conc. circular rail support and timber back wall. Deck $10,830. Thru $11,815. Half thru $10,475. Third class, Conc. center, pile circular rail support and timber back wall. Deck $8,570. Thru $10,080. Half thru $8,[illegible].	Sel. std. conical roller bearing ctr. with ball bearings. Tried only one disc bearing ctr. which was not at all satisfactory and had to be removed.
C.M.&St.P. Ry. 7,481 Miles C.F. Loweth Ch. Engr.	Are ordering no new tables less than 90 ft.	Prefer deck but conditions have arisen where we have put in half thru and pony truss tables. Decks preferred, simpler and less expensive.	90 ft. tables for 250 ton locomotives.	Usually a hand [illegible] of the motor	Power used at the larger tables.	Approach rails spiked to timber coping	Not available.	Our own design of center which has conical roller bearing center with ball bearing disk and thrust. We have had some experience with disc centers which were not satisfactory.
C.C.C.&St.L. Ry. 2,385 Miles G.H. Smith Ch. Engr.	85 ft.	Deck	225 tons	Latch attached to girders and engages a socket in the wall. Where tables are turned by tractors latch is unnecessary and seldom used.	Power tractors on all heavy and busy tables. Both electric and air but prefer electric. Air motors unsatisfactory acct. of freezing in cold weather.	Apch. and cir. rails rest on 3/4" steel plates bedded in conc. 60° circ. At main tabs. the circ. rail is [illegible]	80 ft. table $4,000 Pit ... 3,000 Total $7,000	Disc ctrs. are old. Now used [illegible] experience with disc ctrs. not satisfactory [illegible] plates not adequate.

C.R.I.&P. Ry. 8,020 Mi. I.L.Simmons Br. Engr.	75 ft. Now Contemplating using a 90 ft table owing to increase in power.	Standard Deck. Will use two different depths Shallow type where drainage requires	200 tons 10,000 lbs per sq. in. tension. 6,000 lbs shear	None.	of the our norther future will probably use electric where current is easily obtained	Approach rail spiked to timber coping. Circle rail set on concrete and held by anchor bolts.	75 ft table costs $7,500 90 ft table will cost about $9,000.	Table centers.
C.StP.M. & O. Ry. 1744 Mi. C.W.Johnson Ch. Engr.	80 ft up to date This year increased to 90 ft.	Deck, except when drainage conditions compel use of thru table.	200 tons.	Sliding latch on top of ties but webs of rails operated by hand lever.	Air and electric Favor latter where it is easily obtained	Apch. rails rest on coping timber. Circle rail set on concrete	80 ft. table, engine, frt, etc. $2720 Setting 169 Founda. ties etc. 1831 Total, $4720. Cost does not inc. piles.	Trade Standards.
C.&S. Ry. 1,248 Miles. W.H. Cowan Ch. Engr.	Longest table, 80 ft. Would recommend 90 ft.	Both deck and thru. Latter where drainage conditions demand.	200 tons.	Lock thrown by lever.	All tables turned by electricity or air. Prefer electric	Cast chairs spiked to timber coping for apch. rails. Circ. rails on tie plates, and timber ties set in concrete	80 ft. table, $3,300 Pit, 2,200 Total, $5,500.	Trade Standards, conical roller bearings.
D.&H. Co. 843 Mi. G.H. Burgess Ch. Engr.	60 to 90 ft.	Deck except where drainage condns. compel use of thru.	Coopers E-60. Tension 8,000 lbs per sq. in.	None	Electricity where places air light power Electric most satisfactory.	Apch. rails rest in riv. steel plate chairs anchd. to the conc. Circle rail rests on timber ties bedded in conc. or rests directly on concrete.	90' table, foundn., pit Total, $[illegible]	Trade standard. Conical roller bearings.
D.L.&W. R.R. 972 Miles G.J. Ray Ch. Engr.	90 ft	Deck pl. gir. except where drainage condns. compel the use of through	Tension 10,000 lbs sq. in. Shear 6,000 lbs sq. in.	All have locks	Electricity or air Air used only where electricity is not available	Apch. and circ. rails rest directly on conc. circ. rails and are held by anchor bolts set in conc. Parapet wall under approach rails reinforced by 2 cut-rail rails embed upright in conc.	No information	Roller bearing centers
D.&R.G. R.R. 2,778 Mi. J.G. Gwyn Ch. Engr.	80 ft Standard Only 90' tables used for turning Mallet engs.	Deck. Have a few through tables where drainage condns. demand.	Same as bridge specifications.	Locks not generally used, but when used are bars sliding bet. webs of rails.	Where elec. can be cheaply secured we use it. At outlying pts. air is used being obtained from air compr. or loco.	Apch. rails spiked to coping timber. Circle rail to short ties embedded in concrete	No information	Trade standard conical roller bearing centers.
E.J.&E. Ry. 482 Mi. A. Montzheimer Ch. Engr.	80 ft	Deck	200 ton Stresses conform with specifications of Am. Ry. Eng. Assn.	No locks. The motors and gears hold the table in line. Motors equipped with brakes	Electric. Recom. overhead collector rings as have had trouble from wires placed underground and dangerous crossing short circuits. Also [illegible]	All circle and apch. rails rest on conc. anchored down by bolts set in drilled holes.	80 ft. table $4,500. Complete.	Am. Br. Co's. Conical roller bearing center.
ERIE R.R. 2,511 Mi. F.A. Howard Engr. B.&B.	80 ft Contemplating the construction of longer and heavier tables, up to 90 or 100	Deck plate girders.	Mallet engine with 6 drivers 35,000 lbs. on ea. 12,000 lbs. flange stress per sq. in. no impact.	Bar with lugs at ends slides bet. webs of rails. In a few cases a toggle pin has been used.	Nearly all turned by	Approach and circle rails are spiked to the ties.	80 ft. table: Pit $5,000 Table 3,000 Center 500 Total $8,500	King Br. Co. conical roller bearing center with ball bearings at ends of con. rollers. Trouble with balls. Substitu. [illegible] of con. rollers.

ROAD	LENGTH	TYPE	LOADING, &c	LOCKS	POWER	RAIL FASTENINGS	COST	CENTERS
Grand Trunk Ry. Sys. 4,757 Mi. H. R. Safford Ch. Engr.	80 ft. One of 100 ft. to accommodate Roundhouse of 50 stalls.	Through girders	No information	None	Air motor or electric power.	Approach rails spiked to coping timber and circle rails to ties embedded in concrete	Table, $3,900; Pit, 2,100; Total, $6,000	Ball bearing centers. 36 [illegible] in balls
G. N. Ry. 7,374 Mi. A. H. Hogeland Ch. Engr.	80 and 92'. Desired to get them long enough to bal. [illegible] locomotive	Thru pl. girders. Decks require too much excavation. Thru [illegible] trussed to [illegible] power	80 ft. 180 tons. 92' table 250 for Mallet; [illegible] lbs. sq. in. tension for 80 and 12,000 lbs. sq. in. for 92 [illegible]	Plunger thrown by hand engages socket in circle wall below deck	Air, elec. and gas. motors. Gasolene used only where the others not available. Elec. increased fire risk.	Approach rails spiked to timber coping and circle rail to timber ties.	80, complete $7,900; 92, " 9,700	Trade standards with conical rollers
Ill Central R R 2245 Miles A S Baldwin, Ch Engr	85 and 75 ft. 85 at main line double and other places where required. 75 ft. on branches.	Deck plate girders	200 tons	Std. plan requires no locks. At some points locks consist of a latch on table that drops into a chair on wall	Elec. where current can be obtained economically. Air in other cases. Air gives trouble in cold weather unless all pipes and connections are under ground	Approach rails spiked to timber coping. Circle rail rests on concrete held down by clips and anchor bolts.	[illegible] steel [illegible] $[illegible]; [illegible] 3,300; [illegible] foundation, 1,200; [illegible]; Total, $[illegible]. 75 ft. Steel [illegible]; [illegible] Total, $6,750	Conical roller bearing ctr. with ball bearings
Intercolonial Ry. of Can. 1,438 Mi. Wm. B. MacKenzie Ch. Engr.	75 ft.	Through tables altogether in new work	200 Tons Tension 12,000 lbs. per sq. in.	Bar which engages in a slot	Hand power only.	Approach rails spiked to timber coping. Circle rail to timber ties on concrete circle wall	75 ft. Table; Pit, $3,200; Table, 4,500; Total, $7,700	Ball bearing ctr. Have had some good conical roller bearings, but some failed by flattening
I & G.N. Ry. 1,106 Miles. O. H. Crittenden, Ch. Engr.	70 ft.	Half through girders.	200 tons	None.	Air tractors	Approach rails spiked to coping [illegible] to short ties embedded in concrete	Table complete, $3,850; Tractor, 500; Foundations, 1,150; Total, $5,500	Conical rollers.
K. C. S. Ry. 830 Miles C. E. Johnston Ch. Engr.	90 ft.	Deck girders	260 ton Mallet locomotive 12,000 lbs. per sq. in. in tension and compression	We use a bar which is dropped over [illegible] the rails to hold table in line with tracks.	Air tractors	Approach rails [illegible] to coping timber with screw spikes. Tie plates used. Circle rail to short creosoted ties by screw spikes.	90 ft. complete, $8,500	Am. Br. Co. Std. Conical roller bearing center
L.S.& M.S. Ry. 1663 Miles S. Rockwell, Ch. Engr.	85 ft.	Deck girders	210 tons. 10 wheel [illegible] locomotives 11,000 lbs. sq. in. tension, 7,500 lbs. sq. in. shear	Rail lock operated by hand lever	All newly installed tables equipped with elec. tractors where it is pos. to obtain current	Approach rails spiked to coping timber. Circle rail fastened directly to concrete by bolts and clips.	Table costs about $3,800; complete installation from $6,000 to $8,000	King Br. Co. std. conical roller bearing center with [illegible]
Lehigh Valley R. R. 1422 Miles. [illegible] Ch. Engr.	80 ft.	Deck girders	Coopers E-60 stresses [illegible] by Am. Ry. Engr. Assn. with [illegible]	Locks [illegible] provided at all [illegible] of other pits. [illegible] bars [illegible] engaging bracket in circle wall. Driven by spring, withdrawn by cable.	Elec. where available. Next in order gasolene motor, then air motor.	Approach rail spiked to timber coping. Circle rail to short ties on circle wall.	80 ft. table, $[illegible]; [illegible] full pit, [illegible]; Drainage, [illegible]; Circ. Rails, [illegible]; Sundries, [illegible]; Total, $[illegible]	Trade ch. with conical rollers [illegible]
Long Island R. R. 393 Miles. J. R. Savage Ch. Engr.	80 ft.	Deck girders	Coopers E-50 [illegible] lbs. sq. in. tension, [illegible] lbs. shear	Toggle bar bolted to a pair of angles.	Gasolene for tables operated frequently. Others air	Approach rail spiked to coping timber. Circle rail spiked to short ties embedded in concrete	80 table, $2,6[illegible]; [illegible]; [illegible]; Deck, etc. [illegible]; Total, $[illegible]	Conical roller bearings with live ring

4,690 Miles. W.H. Courtenay Ch. Engr.		[illegible] girders preferred. Thru girders used only when [illegible]. At some shops for [illegible].	192 tons with engine. Tension 16,000 lbs. per sq. in.	Rail lock consists of flat I shaped bar worked by hand.	Elec. tractors where current can be obtained. No other power has been used.	Approach rails spiked to coping timber. Circ. rails spiked to short ties embedded in concrete	No information	Trade standards. Conical roller bearing ctrs. with [illegible] ball bearings. [illegible] not satisfactory.
Maine Cent. R.R. 932 Miles. T.L. Dunn Ch. Engr.	80 ft	Deck girders except one through.	Cooper's E-50 10,000 lbs. sq. in. web shear 7,500 sq. in.	Tables turned by power held in place by brake on engine. Others by latch [illegible] & socket in pit wall.	Electric power used on some tables. Others turned by hand	Rails held to circle wall by cast iron clips and bolts.	80 ft table, . $8,000	Disc center, per N.Y.C. standard.
M.&St.L.R.R. 1,610 Miles. R.G. Kenley. Ch. Engr.	70 ft. Need 75 or 80 ft. to bal. our heaviest eng. with tenders empty.	Deck [illegible] Thru where [illegible] of deck pit too expensive as in solid rock, or [illegible]	52 ton engines [illegible] lbs. sq. in. net section	Yoke design for end latch to hold table in line. Latch operated by hand.	One table operated by air.	Apch. rails spiked to coping timber. Circ. rails spiked to short ties resting on conc. circle wall	70 ft. table Deck, . . $4,570 Through, 6,500	Trade standard Conical roller bearing centers.
Mo. Pac. Ry. System. 7,236 Miles. C.E. Smith Bridge Engr.	75 ft. Future tables should be longer.	Deck girders	200 tons. 10,000 lbs. per sq. in.	Sliding I shaped bar between webs of rails, op. by hand.	Use electricity, gasoline, and air [illegible] for tables only.	Apch. rails spiked to tim. coping. Circ. rail spiked to short ties on conc. wall. In some cases. In many cases, [illegible] used in place of concrete	75 ft complete with [illegible] wall and under [illegible] $4,500 With concrete wall and brick paving. $6,000	Trade standards with conical rollers with ball bearings when we can get them.
M.&O.R.R. 925 Miles. B.A. Wood, Ch. Eng. Maint.	75 ft. Expect to inc. length of std. to 80 ft.	Deck girders.	Cooper's E-55 with stresses of Am. Ry. Eng. Assn.	Movable iron Clamp.	Gasoline engines on 75 ft. tables. Others turned by hand.	Apch. rails to coping timber. Circle rail to short ties.	75 ft. table, $2,280 Pit & installin, 2,250 Gasoline motor, 1,200 Total, .. $5,730	Conical roller bearing centers.
N.C.&St.L. Ry. 1330 Miles. H. McDonald Ch. Engr.	90 ft. Deck girders, would go to great expense, say [illegible] in foundations to avoid through tables.		Sol. E-60 loading with stresses of Am. Ry. Eng. Assn.	Lock used only on tables turned by hand	Electric tractor which gives good satisfaction	Apch. and circular rails attached directly to concrete by steel clips and bolts.	Excavation, $1,000 Concrete, 1,400 Circle rail, 150 Table, 3,500 Flowline, Tracks, Pipe, 1,635 Total, $8,[illegible]	King Br. Co. and Am. Br. Co. centers. Much prefer con. roller bearing centers.
National Rys. of Mexico, 7,408 M. Jas. M. Reid Ch. Engr.	75 ft. for ord. conditions and 80 ft. where Mallet comp. engs. are used.	Deck Girders	75 ft. table 250 tons. 80 ft. table, 254 Ton Mallet	[illegible] are used.	Two tables turned by elec. motors. Others by hand	Rails attached to timber coping and ties or to cast iron chairs.	75 ft. table at N.Y. $3,000 Freight, [illegible] 300 Erect. & pty. 300 Pit, 2,500 Total, $6,100. 80 ft. Table N.Y. $3,300, Frt. [illegible] Erec. & Painting 450. Deck 300. Pit [illegible] Total $9,000.	Table centers with conical roller bearings.
N.Y.C.&H.R. 3,381 Mi. G.W. Kittredge Ch. Engr.	85 ft.	Deck girders. In cases where necessary a through or half thru is used	246 ton Mallet engine 10,000 lbs. per sq. in. tension 7,500 lbs. sq. in. Shear.	Forged bar in the shape of I worked by hand.	Elec. where power is available. At other points gaso. engine. Elec. for tractor is run up thru center	Rim of circ. wall surmtd. by an 8 in.–41 lb. beam bent to circ. and bolted down. Apch. rail bolted to flange. Formerly rested on [illegible] curved rails embedded in conc.	Deck table, $2,800 Through, 3,600 Pits for tables run from $3,000 to $8,000. Std. table complete, $[illegible] to $11,000	Disc centers on rollers, high pedestal.
N.Y.N.H.&H. R.R. 2,047 Mi. E. Gagel, Ch. Engr.	75 ft. std. Some 80 ft. tables have been built	Deck girders. Where nec. we use through girders.	190 ton Pacific type. Am. Ry. Eng. Assn. stresses	A forged hinged lock placed in the center of the track	Power is used at all [illegible] "gasoline" engines.	Circ. rail rests on short ties in some cases and on conc. in others. No information.	Deck type, av. $6,400 Through, 9,300 Tractor, . . 1,000	King Br. Co.'s or Am. Br. Co.'s Standard conical roller bearing ctr. with either ball or bronze thrust bgs.

ROAD	LENGTH	TYPE	LOADING &c	LOCKS	POWER	RAIL FASTENINGS	COST	CENTERS
Norfolk & Western. 2,381 Miles. C.S. Churchill Ch. Engr.	100 ft.	Through girders with std. floor sys. on acct. of depth of pit and drainage	8000 lbs. per lin. ft., and are tested 7000 lbs. per lin. ft. both arms loaded 10,000 lbs. per sq. in., no impact.	Tractors have brakes which hold table in line.	When electric power is available we prefer electric tractors	Approach rails spiked to coping timbers. Circle rail spiked to short ties on concrete wall.	100 ft table . . $5000	Heaviest trade standard, Conical roller type
Nor. Pac. Ry. 6,019 Miles W.L. Darling Ch. Engr.	85 ft.	Thro. girders with standard floor 3'-7" to top of center concrete	20 % for engine 8000 lbs. per sq. in.	Locks used.	Air and electric. Prefer electricity where available.	Approach rails on coping timber. Circle rails spiked to short ties on concrete wall.	No information	Standard conical roller bearings
O.S.L. R.R. 1646 Miles C. Stradley Asst. Gen. Mgr.	80 ft. Since the advent of the Mallet engines, to put in some 100 ft.	80 ft. Deck 100 ft. Table is a pony rib. Warren truss.	192 % for consolidation.	Tractor brake holds in line.	Electric power in all cases.	No information.	Tables 66' to 100' long have varied in price from $6,000 to $25,000	Standard center with conical rollers
O.W. R.R. & Nav. Co. 1,888 Miles G.W. Boschke Gen. Mgr.	80 ft.	Deck girders	192% for consolidation.	Use tumbler and drop with a guide at each end	Use either air or electricity wherever we have shops.	Approach rails spiked to coping timber.	Weight 72,000 lbs. Cost . . $8,000	Conical roller center with live ring.
P.R.R. 2,586 Miles. A.C. Shand Eng. B.&B.	85' and 100'. Latter used to avoid frogs.	Deck girders. Pit 11'-3" to top of rails. [illegible] for 100' table.	226 ton Pacific type, 6,000 lbs. per sq. in.	No standard device	Majority operated by power; principally electric.	Approach rails spiked to oak coping timber. Circle rail to short ties on concrete circle wall.	No information	Conical roller bearing center.
Pa. Lines W. of Pgh. 2,889 Miles. J.C. Bland Engr. of Brs.	75 ft. for minor lines 85 ft. for main lines.	Deck tables.	Computed for heaviest engines existing and regular bridge stresses.	No information.	No information	Approach rails spiked to coping timber. Circle rail spiked to short ties on concrete wall.	No information	King Bridge Co's. standard conical roller bearings with ball bearing ends.
P.&R. Ry. 1,019 Mi. Wm. Hunter Ch. Engr.	75 ft. standard, One table 65 ft.	Deck and through, depending on drainage conditions.	Cooper's E-55 about 10,000 lbs. per sq. in. no impact.	Tongue slides in grooves on table and engages chair on circle.	Motors on tables having a large amt. of work to do. Elec. or Gas. as may be convenient.	Apch. rails spiked to coping timber. Circ. rail rests on C.I. chairs, and held down by clips and bolts on concrete wall	About $4,500, exclusive of foundations and motors	Conical roller center.
P.&L.E. R.R. 218 miles. J.A. Atwood Ch. Engr.	90 ft. for future construction.	Deck girders	Stresses not over [illegible]	None	Electric tractor at important points.	Rails spiked to timber ties.	Foundations. [illegible] Table. [illegible] Fastenings. [illegible] Total. [illegible]	Trade standards. Conical rollers have given good service.

St. L. & S. F. R.R. 4,752 Mi. M. C. Byers, Ch. Eng. Opr.	75 ft. for the last 10 years. Will probably install 90 ft. from now on. May install a few 100 or 105 ft. for Mallet locomotives.	Deck plate girders up to date. May possibly use a through table for Mallet engines.	For 85 ft. table [illegible] E-35, [illegible] heading [illegible] locomotives. 25% impact in [illegible] girders [illegible] in [illegible]. 16,000 lbs. per sq. in. in tension. Do for shear.	Not generally provided as former latches [illegible] used by workmen.	Tollow air motors on all tables where air is available.	Apch. rails spiked to coping timber. Circle rails rest on [illegible] partly embedded in concrete circle wall.	75 ft. table, $2,500; Setting, 500; Pit, 3,500; Total, $6,500	Trade standard center; [illegible] Rife Bridge Co.'s conical roller center with ball bearings. Have one disc bearing one in use 15 years and in good condition.
Seaboard Air Line Ry. 3,008 Miles. W. L. Seddon, Ch. Engr.	85 ft.	Deck plate girders. Would use through table if necessary to get drainage.	Engine of equivalent to Cooper's E-50, but 20% longer. 14,000 lbs. per sq. in.	Hand operated tables locked with bar between rails. Others are held by brake on tractor.	All tables 75 ft. long or over are operated by power. Usually gasolene, but electric power preferred.	Apch. rails rest on coping timber. Circle rail on short ties embedded in concrete of circle wall.	Table, $2,000; Motor, 1,100; Pit, in hard clay, 5,046; Total, $[illegible]. This will vary according to conditions.	Trade conical roller bearing centers.
Southern Ry. 7,039 Mi. B. Herman, Ch. Engr. M. of W. & S.	Latest table 90 ft. long to turn Mallet engines.	Deck girders.	263 ton Mallet engine. 10,000 lbs. per sq. in. no impact	Sliding latch against web of rails	All tables much used equipped with power. Prefer electric where available. Next preference is air from shop or locomotive; in other case using an accumulator. Have had good success with the Mc. Grath air motor. Have also used steam and gasolene with good results.	Approach rails spiked to timber coping. Circle rail spiked to short ties embedded in concrete of circle wall.	No information.	Trade standard conical roller bearings.
U. P. R.R. 3,507 Mi. R. L. Huntley, Asst. Gen. Mgr.	80 to 100 ft. Latter required to turn Mallet engines.	Deck girders for 80 ft. Pony trusses for 100 ft.	192½ ton engines for 80 ft. 307 ton Mallet for 100 ft. 12,000 lbs. sq. in. stress.	Where turned by hand movable bar is used bet. rails. Where power is used, depend on brake on tractor.	Hand power, 33; Air, 3; Electricity, 9	Apch. rails spiked to timber coping. Circle rail [illegible] in concrete with about [illegible] in. of head protruding.	No information.	Standard with conical rollers.
Wabash R.R. 2,515 Mi. A. O. Cunningham, Ch. Engr.	75 ft. Future tables should be longer.	Deck and through. Latter only where it is impossible to get drainage for deck pit.	200 ton consolidation and Pacific type engines.	None.	Where cheap electric conditions permit	Approach rails spiked concrete circle wall	Pit and Foundation, $3,360; Deck table, 2,430; Rails, 685; Motor, 1,075; Total, $7,550	Trade Standard with conical rollers. Disc center should prove satisfactory if properly designed.

DISCUSSION.

The President:—This report exhausts the subject very thoroughly and gives us a fund of information which is just what we need at this time. I hope we will have a thorough discussion of it. I will ask Mr. C. E. Smith, the chairman of the committee, to bring the subject before the meeting.

Mr. Smith:—Since this report was prepared, I have learned of a proposed engine called the Henderson Triplex, on which, I think, it is proposed to have three sets of drivers, instead of two; three complete engines under the boiler and tender, with six-wheel trucks. I expect that engine could be turned on a 175-ft. turntable, but I don't think that such a turntable should be built. Such an engine ought to be turned on a wye where there is plenty of room for it.

I hope that the convention will not think the subject has been covered. I think that you gentlemen who have had experience in maintaining turntables for a number of years, can bring before this convention more important information than is given in this bulletin. Personally, I would like to hear a thorough discussion on it.

The President:—This subject has certainly been ably presented in the report and I hope that every member will take part in the discussion, to give all the facts and experience he may have had to the convention.

Mr. Pickering:—I am not in favor of the disc center. I have had some rather unpleasant experiences with them; in fact, all of the turntables above 60 ft. in length that I have on my division have disc centers. All of them, with one exception, are turned by gasoline power. We have had great difficulty in maintaining the gasoline engines. I questioned why we should have such difficulty, but I found that when the gasoline motor was out of order, it took from 10 to 15 men to turn our Pacific type engines on these tables, even after disconnecting the motor and I decided there must be some difficulty with the center. I had the centers very carefully examined, and I found that in almost every instance, they were not turning on the phosphor bronze center disc, but on the top of the follower cap, or the under side of the follower cap was turning on the top disc, with iron in contact with iron, or steel in contact with whatever the metal might be, although it is usually steel.

I installed a 75 ft. table early this year where there was comparatively little traffic, possibly 10 or 12 engines per day being the maximum number turned. It did not seem that we could afford to install power to turn it, as the conditions did not warrant this. We tried turning it by hand. Fortunately, we got the table installed possibly a week before the track was ready and the men reported that they could not turn the table. It was the same type of center that is illustrated in the report as the Missouri Pacific 1,000 ton draw bridge center. The men reported that it took six men to turn the empty table. I immediately decided that something must be done, because, if we got a Pacifie type of engine on that table there were not enough people in the village to turn it around. I consulted my division foreman and we decided to make a steel disc in two parts to take the place of this three-part disc center. The steel used was a low grade of tool steel, tempered to practically as hard a temper as it would take, which was not a brittle temper by any means. We installed this center and found that, instead of six men being required to turn the table, by using a good deal of effort, one man could swing it a quarter of the way around the circle and leave it and it would go four complete revolutions before it stopped. I took the matter up immediately with the builders of the turntable who were very anxious to find the difficulty. They sent their engineer from their works in Pennsylvania to see this table. As we were still in the experimental stage, to some extent, we took our steel center out and had their center in when the gentleman arrived. I invited him to turn the table, but he could not budge it with all the force he could apply, and he was quite a rugged man, too. At that time we had the track connected with the table and we put on three different classes of engines. The least number of men we could turn the engines with was and it required eight men to turn the table with the heavier type of engine just mentioned, weighing 110 tons and they had to work hard. I did not time them accurately, but it required not less than four minutes to turn one of this class of engines with eight men. We tried this to his satisfaction, then removed that disc while he was there and put in our steel disc and two men turned our heavest type of engine, easily. This was quite a revelation to the engineer, as it had been to me, and he tried to come to account for it, but I thought that was for him to determine. He requested me to return the phosphor bronze discs

to their works for regrinding, which I did. In fact, I returned two of the phosphor bronze discs with the steel upper and under discs which were sent back to me after refitting. One of them worked fairly well and six men would turn a Pacific type engine with comparative ease. We have continued the use of this steel disc to the present time and it has given splendid satisfaction. We have had no difficulty whatever with it. The other disc was no better than before and it was returned. The one which was retained was removed a short time ago and was found to be in perfect condition. The surface was very bright and smooth. It runs in an oil bath and apparently showed no signs of wear. One point I want to make against this steel disc as shown here is that there is a large hole through the center of the disc, the same as in the disc I mentioned; just so that there is a vacancy where the greatest bearing strain should come. This transfers the load outside of that center bearing point and the larger we make that bearing surface, the harder the table is going to turn. This gentleman tried to persuade me that the table turning hard was no material disadvantage where we had power to turn it, but I didn't take that argument very pleasantly. I think these centers should be designed to turn with the least amount of friction possible. I immediately decided in my own mind that the reason why the gasoline engines were giving so much trouble on the other tables was that they were simply overloaded. To turn the empty table was too much for them, to say nothing about turning a Pacific type engine.

I have a great many 60-ft. roller-bearing tables that turn our Atlantic type of engines, in fact, turn anything that has a wheel base short enough to get on the table, and I have no difficulty whatever with them. We plan to take the bearings out, clean them thoroughly and oil them once a year, and when this is done they give us no trouble and turn easily. I have none of that type of tables equipped for power turning as we find no difficulty in two or three men turning the largest type of engines that we can get on a 60 ft. table. I believe that the roller-bearing center is much preferable to the disc center.

Mr. Smith:—We have, or did have, until we took a few out some years ago—about forty of the old Union Bridge Co.'s 60 ft. tables on the Missouri-Pacific. They are supported by tall cast iron pedestals, over the top of which there are saddles. In the tops of the pedestals are what we call buttons as shown on the plan. This button is really a phosphor bronze disc about six inches

in diameter, as I remember it. We have never had any tables that turned any easier than those, until they were overloaded to the point where the pressure between the phosphor bronze and the steel got above 6,000 or 7,000 lbs. per sq. in. The oil then squeezed out from between the steel and the phosphor bronze, for there s no oil that will stand that pressure. As soon as we get metal on metal the phosphor bronze button cuts out rapidly and re-uires renewal and the turning of the surfaces on which it rests.

The matter of using a disc is entirely a matter of design. If is properly designed and the pressure is kept low enough, say elow 6,000 lbs. per sq. in., so that the oil will distribute itself etween the discs and will not squeeze out, I think it is a very sy turning type of center.

Mr. Jutton:—There is one thing that has not been touched on t in the discussion, and that is the paving. As I remember, the port states that paving depends on local conditions, and that it is rd to see where one secures a return on the money expended paving in a turntable pit. I think that most turntables are glected a great deal. They are allowed to get dirty and rust and corrode. A dirty pit adds to that condition. ertainly adds a great deal to the appearance of a turntable and surroundings in general to have the pit paved. One would think of putting a pump or similar equipment below the surface he ground and leaving the pumphouse with no paving, other dirt or cinders but it is fixed up nicely and kept clean. When nes are moving on and off a turntable dripping water, cinders all kinds of grease and oily waste collect. I find that after man in charge of the table turns an engine he goes and sits n, lights his pipe and waits for the next engine. He don't hese little things that he might be doing in keeping the table and thereby preserving it. For that reason, we have to do thing to keep the pits clean, if we can't control the men. I thought that if some kind of a water tight covering,—say a covering,—could be put on the ties, all the dirt and grease l be caught on this top covering where it could be easily d off and would not get to the metal. Carrying out the same one would want a paving below. These two improvements add considerable to the life of the metal. In addition, the should be kept well painted.

think we have two or three tables on the Northwestern at the pit is completely covered, probably on account of snow.

The men operating those tables seem to think they could not get along without that pit covering. I know the table at Escanaba, Mich., where we generally have a good deal of trouble in the winter time, is provided with a stove and the pit is covered over so that they keep the table warm in the winter time.

The committee cites a disc center for a drawbridge. A drawbridge has the rollers under the rim, in addition to the center, and the two work together in turning. Of course, one might say we have the same thing on a disc center turntable, but the rollers, instead of being at the center, to take up the side-tipping, are at the ends of the table. This matter of side-tipping in turntables is very serious and I should think it would be more so in a disc center, especially when a table is overloaded. In overloading an old table, one must keep it high enough so that the deflection will not bring too much bearing on the end rollers. Also if the table is high it allows of more side-tipping. Under those conditions it is hard to operate the table and one always has a great deal of trouble for that reason. I believe the committee recommends that the table should be of sufficient strength that the end rollers shall be only ¾ in. above the circle rail when the table is not loaded. With a deflection of ½ in. that would leave ¼ in. at each end. This would be impossible with an overloaded table, the deflection being a great deal more. In regard to these conical center roller-bearing turntables, Mr. Finley, our assistant chief engineer, has raised the point that the device to hold the live ring right in place should hold every roller where it belongs, because the instant one of those conical rollers is displaced, there is no bearing on it and the pressure is correspondingly increased on all the others. In his opinion, that is something that should be looked after carefully. The photographs in the report showing the standard roller centers of the Chicago, Milwaukee & St. Paul table have in addition to the bronze washer at the outer edge of the conical rollers a ball-bearing ring at the center and the two are tied together, keeping the conical rollers where they belong, which appears to be a very good detail. However, I want to say again that what seems to me to be the secret of turntables operating nicely, is to keep the centers and everything about them clean and to use a good quality of oil in the center. Then when it gets down to 10 or 20 degrees below zero, one won't have as much trouble as if he had not kept the table clean.

Mr. Reid:—We have a drawbridge 123 ft. long, over the Grand river, which was used for a time on the main line, and later,—after

he main line was double tracked,—it was taken down and erected it Grand Rapids. This has a disc bearing which carries the entire lraw span, the pony wheels being designed only to prevent tipping. Both ends are raised with a mechanical lifting apparatus before urning. Two men turn that bridge under any conditions, and nany a time one man will turn it. We have had no trouble when is kept properly oiled. The river is frozen in winter and the ridge is not opened. In the spring the river frequently gets up that it deposits mud and rubbish over the pier and has been as high as the ties on the bridge. At such times a great deal of diment is deposited all over the bridge and we have to clean it oroughly. We have never attempted to put water-tight planking er the centers of our tables, on account of the frequent de-ilment of engines. The enginemen or roundhouse men operating e tables are not as careful as they might be in lining up the ils and in locking the tables in position for the engines going on d off, and frequently they run almost entirely across the table the ties. Of course, that would ruin any water-tight floor. It bad enough on the ties, but they can be replaced with com-atively little trouble, and a water-tight floor is expensive to re-ce every little while. We have water-tight floors over the drums l centers on our drawbridges to keep out cinders and other use that drops from passing trains. They are a help, but do keep out all of the dirt, because cinders will get in anyway.

Another trouble that we have had, and probably one of the icipal troubles we have with our turntables, is a lack of at-ion on the part of the men in charge. They prefer to do any-g, apparently, except take care of them. They don't oil them, cially where they have power tables. I have seen pony wheel nals taken out where the journals have worn two inches into cast iron bearings of the table, and I have seen pony wheel nals worn entirely off. Another trouble arises on account of difference in elevation of the rail on the table and the rail on ipproach when an engine is coming on or going off This always es more or less pounding and the rivets or bolts in the floor-is supporting our end trucks have worked loose in a few cases ng us some trouble. Another difficulty is the cutting of the ties on the parapets. I should think that in some of the mentioned in the report here, the bedding of I-beams or rails concrete parapet would be even worse than the use of oak When an engine drops off a table or climbs up off the table

on to a rail bedded on a steel I-beam or any other rigid material in a concrete base, it is only a question of a short time until the concrete will wear or the steel will loosen up and begin to churn. I should think an 8 in. parapet timber or oak tie would be far better. We use those on the Lake Shore. In regard to the circle rails,—the best of our tables have creosoted ties buried in the concrete and the circle rail is carried on them. In those cases we have had very little trouble.

One question raised was that of lubrication and the squeezing out of the oil on account of excessive loads. On some of our turntables and on all of our drawbridges, we use graphite grease for heavy lubrication and it is the best thing I have been able to find. We have never found a case yet where graphite grease would not work effectively, no matter how heavily loaded. If the grease squeezed out, the graphite remained, and that in itself is a very good lubricant.

Another trouble with the table has been the excessive deflection. One result of excessive deflection is the necessity for setting a table high on a center in order to clear the end rail when loaded. I have seen tables that would sit with one end bearing on the circle rail and the other end would be 3 in. above the rail, but when loaded both ends would be down on the rail. If an engine comes on the table, with any speed at all, it makes a tremendous pounding, throwing the receiving end of the table down 1½ in. That brings us back to the necessity of designing a table that is rigid enough to eliminate excessive deflection. The suggestion of designing a table to give ¾ in. clearance when light and ¼ in. when heavy, is a good one. It looks doubtful to me, though, whether we could get an 85 or 90 ft. table which would not have over ½ in. deflection under the maximum load. I don't say it can not be done, but it would require a heavy table to do that. With the constantly increasing load and the naturally increasing length of the table, in my own opinion, it is only a matter of time when we will have to come to a through girder table in order to get the proper depth of girder without an excessive depth of the pit.

Mr. Smith:—I am surprised that bridge engineers and other officials of railroads who have to do with the designing of turntables, have let themselves go so far wrong as to design them too light. The railroads write specifications for bridges, but the great majority of the roads, probably 95 per cent of them, are still buying turntables handed to them by the manufacturers. Those turn-

tables are bought on a competitive basis. I got my knuckles cracked two or three years ago, when I turned down a standard design of a turntable that had been adopted by a great many roads, and that was made by a firm that manufactured and sold hundreds of turntables, and adopted in its place a design which showed a much heavier table and which cost more money. The management bought two of the heavier tables, but a week later we got a letter saying that twenty of the ligher tables had been bought. The chief engineers and bridge engineers are considerably to blame, but they have to maintain the tables after they get them. Now, this report says, "Although a bridge designed for Cooper's E-50 or other Cooper's loading will support, without any increase in stress over that used in the design, actual modern engines considerably heavier than the Cooper's loading, (on account of the longer wheelbase of the modern engines distributing the load over a greater length of bridge) the same engine on a turntable will cause the stresses that affect the deflection of the ends to very materially exceed those used in this design for the reason that the longer wheelbase increases the negative bending moment on a turntable. This is well illustrated in the diagram comparing the effect and appearance of Cooper's E-50 loading to modern heavy Mikado, Pacific and Mallet type engines which cause stresses in bridges approximately equal to those caused by Cooper's E-50. On a turntable the negative bending moment at the center corresponds to that caused by Cooper's E-100 for the Mikado, E-110 for the Pacific and E-170 for the Mallet. If the turntable were designed for any such unreasonable values of Cooper's loadings the tresses in other parts would be increased out of all proportion to the requirements. The reason why Cooper's loadings cannot be used in turntable design is readily apparent from the above. It appears that the tables should be designed for the heaviest actual engine in service anywhere that could use them." On that basis, the Missouri Pacific is still designing their bridges for Cooper's E-50 loading, and will probably continue to do so, but it works exactly opposite in the case of a turntable. The figures shown in diagram, on page 154, account for the excessive deflection that Mr. Reid tells about. He wouldn't have a bridge in his territory that gave a 3 in. deflection; but compares the Cooper E-50 loading at the bottom of the page with the Mallet compound at the top. All bridges designed for the Cooper E-50 loading at the bottom of the page can be used for the Mallet compound, but I wouldn't let that Mallet compound on a turntable I had built

for a Cooper E-50 loading, for the reason that the moment at the center on the Cooper E-50 is 2,149,260 ft. lbs. and on the Mallet compound it is 7,228,000 ft. lbs., about 3½ times as great. Now, the engineers who have had the designing of turntables to do, are responsible for that condition. They give you a "paper" turntable and it don't stand up. Turntables should be designed so that they will stand up, and if that fact can be hammered home, we have accomplished something. In regard to the tipping of drawbridges on disc centers; the last three years I put in four drawbridges that were 270 ft. long, single track, but very stiff riveted, each of the four. My own experience on two other roads had led me to believe that disc centers for drawbridges were best. The American Society of Civil Engineers went into the subject a few years ago and recommended the use of disc centers under drawbridges. One of these four drawbridges was a single track 150-ft. deck plate girder draw, that can be turned by one man. I have run around with the lever and left the table spinning. The leverage there, of course, has to be multiplied by gears. Two other drawbridges were 270 ft. long, single track, but very stiff riveted structures, turned by one man. The drawbridge referred to in the table is a 260-ft. double track draw and very stiff. The eight wheels are for balancing purposes only. Before the draw was accepted, it was so adjusted by a machinist of the bridge company, that when the draw was turned by the gasoline engine, not one of the eight wheels turned. They were adjusted to a little less than 1-16 in. above the track. We swung the bridge about a dozen complete circles and kept it spinning and not one of those wheels touched the track at any time. They will touch occasionally, but the load on the wheels will be inappreciable as compared with the load on the center.

Mr. Alexander:—We had quite a number of Fritchie turntables on our road originally with two steel discs, 6 in. in diameter working together. They were very satisfactory tables when properly adjusted, and turned easily, but we found that in our climate the frost and ice affected us so much in the winter time that we had to allow more tip to the table than was proper, on account of the ice raising the circle track. When the table was in that condition, if an engine happened to be one-sided, because of a large air-pump, or of the coal being loaded wrong the table would tip to one side. These tables had an extra bracing of angle irons riveted in place but they could not prevent the table from tipping

if two or three wheels on one side touched the rail, the very hard to turn. We overcame this by putting in a ter.

we got several 60-ft. Edgemoor tables and found no ith them. Two men could easily turn the largest engine n them. The end wheels were a little larger on the than on the Fritchie table and very loose in the boxes ey would adjust themselves. These Edgemoor centers of rollers three in. long and three in. in diameter at the . We thought of putting that kind of a center in the able to overcome our difficulty and did so with good re- fterwards, we wanted a larger table and we got four girder tables with conical roller centers from the Penn- Steel Co. This type of table had hardened rollers nine nd five in. in diameter at the large end. These rollers properly adjusted and the tables turned very hard. I was vestigate the trouble and I found that the pitch of the s not just right, although only a very little off, creating friction. We wrote to the Pennsylvania Steel Co. about they sent us new centers, similar to that of the 325-ton ia turntable shown in the report with inside and outside ands or rings with pinions in each end of the rollers, serve the spacing of the rollers and prevent their rubbing We have had no trouble with that center, but the four ls in that table are smaller and are too tight. If they the end the table is almost hung up but there is a friction the center so that one can balance the engine and prevent of the table from striking. We have very little trouble end wheels, although if they do strike they are too tight. engineers thought the girders of the Fritchie tables were a weak and we put a core plate on the bottom and top of em when we changed it. We had a great deal of trouble last one which we only changed last summer and the complimented me a few days ago on the good job we did ve never had any trouble since we changed the center. was all right, but the table would wind and the wheels ike on both ends of the table. Also the first Fritchie got had adjustable bracing and when it got in wind a little, adjust it with the rods. They never sent us another like ent the other with angle irons riveted in. When they got we had to adjust them by the corner. The Edgemoor

table has a cross-bracing, which is adjustable, that is, a turnbuckle is provided on some of them.

Mr. Clark:—There is another phase of the turntable discussion that has not been touched on yet, and that is the power for turning the tables at small stations. We have been told by some that they turned the tables by gasoline engines and some by electricity, but at stations where one cannot well install such power we have been using the air motor tractor to some extent, with very good results. We take the air from the engine that is being turned.

Mr. Pickering:—Do you have any trouble with air motors freezing up?

Mr. Clark:—No sir, I never had any freeze up.

Mr. Smith (reading from committee report): "Expressions from a few roads are as follows:"

A. T. & S. F.;—Air motors will work satisfactorily if proper care is exercised in the arrangement of the drainage to prevent freezing. The motor is not fool-proof, but it has given extremely good service on our lines.

B. & L. E.;—We would use no other power than electricity unless current could not be obtained.

B. & M.;—We have installed many gasoline motors, but are changing to electric motors wherever current can be obtained.

C. R. R. of N. J.;—We use air supplied from locomotives.

C. & N. W.;—Electricity has proved very satisfactory and has been installed at all points where we generate our own power.

C. R. I. & P.;—We use air motors. We do not find these very satisfactory on account of the motors freezing up on our northern territory. In the future we will probably use electricity where current is easily obtained.

C. C. C. & St. L.;—We find air motors unsatisfactory on account of freezing in cold weather and more expensive to maintain than electric.

E. J. & E.;—We recommend overhead collector rings as we have had trouble from wires placed underground on account of dampness causing short circuits and ice in the pit affecting low collector rings.

Great Northern;—Gasoline is used only where air and electricity are not available. The objection to gasoline is the increased fire risk.

—Air gives trouble in cold weather unless air pipes are ergground.

Clark will read the last six or eight pages of the report l what 57 roads say about turning their engines.

ıtton:—I think it is very important to have a good for the circle rail and to have the rail in good surface, stands to reason that if the circle rail is high in some the load on the table is such that the clearance between eels and the circle rail is very small, when one comes pot, he has to raise the engine over it. I have heard of they balanced the engine several times to get it over spots caused by heaving from frost. If one has a ıdation that the frost can get at he is liable to have a on the circle rail in the winter time.

xander:—I would say that we have concrete founda- ɔ not heave, but we have rain storms in the winter trouble. We lay short ties on concrete under the They are fastened to keep them from shifting the to anchor them down. The rain falling on the con- rk under the tie and lift it. We can't avoid that, but tself does not move.

ɔn:—It is also very important to keep the ties in good a few get soft, one has low spots, and there is apt ɔot where the engines go on and off the table.

cander:—We put stronger ties in such locations to that.

. Markley:—We put concrete under the ties and also ies up to the top on the inside of the circle, sloping center, on the in-going and out-going tracks. Where ɪe roundhouse we lay three rails and anchor them e concrete, which overcomes all of that difficulty. ɔne table put in in this manner, in Chicago, for four e had no trouble from this. On the ties, however, plates the full width of the tie to prevent the rails ıto them.

rence to the center, an improvement can be made cone-shaped center that I believe would prevent ɪst getting into the oil. Dust and dirt getting into enter is the cause of one of our greatest troubles. brought up to the top of the rail on the lower bed, ɔf the rollers, clearing the upper casting about one

inch and the space filled with oil, it would prevent any dirt from getting into the center and would not cost very much.

One of the gentlemen spoke about a roller bearing on the end of the rollers. We have two tables of that class, built by the King Bridge Co., one of them with the end friction roller on the end and the other without. We installed them the same year and never could see very much difference in the operating of the tables. The one without the roller bearings operated about as well as the other one with them. The rollers get displaced and they have to be renewed, costing about $40. We also have a table where the rollers are all kept separate but one would scarcely see any difference in the turning from the other tables that are not keyed.

We have trouble on account of over-load. If an engine breaks the roller cage it is out of service for about five days before we can get a new cage made. We recently installed a new center in a table in Brazil, Ind., with a steel roller bed on top and bottom. We have not had sufficient experience with it to know whether it will work out or not. One has to take out the other rollers every six months or a year, clean them and in many cases chip off the top or lower castings on account of the rollers wearing into the bed so that the castings bind on each other.

Mr. Penwell:—I am glad that Mr. Markley brought up the point of the end bearing on the cone-shaped rollers. That has been a source of annoyance with us. We use the type of table that he speaks of and as the little balls designed to take up the friction on the end of the controller and the plates become worn a little, the balls will get through on to the rollers, cut ridges in the track and ruin the whole center. When we first put in a center of this kind, not anticipating any trouble, we paid very little attention to it; but the first time we cleaned it, we found 15 or 20 of those little rollers ground into the bed. We finally became disgusted with the little balls and took them all out and I could see no difference in turning the table. That center was so damaged by those little balls, that we finally had to change it out.

Mr. A. S. Markley:—Didn't you have to substitute a plate on the end of the rollers for the friction rollers?

Mr. Penwell:—We used the same plate that was on them. We simply took these little balls out and operated the table without them. The plates on the end would turn and take up the friction to a certain extent. I talked with the master mechanic

who operated that table and he said he could see no difference in the turning of it; and they were turning it by hand at that time.

We have been bedding our circle rail on the concrete wall, but this is not entirely satisfactory, as it cuts into the concrete where the engines go on and off the table. Also the ice falls under it in the winter and causes a bad surface in the circle rail. I am inclined to think that the plan of having the ties bedded in the concrete would be a good thing if we could use creosoted ties and proper tie plates.

Mr. Pickering:—There is a point that I would like to make in regard to the ice forming back of the circle rail where it was laid directly on the concrete. We had a lot of difficulty along that line. Up in our country we get a snow storm, followed probably by rain. The man who takes care of the turntable will not get the snow out from back of the circle rail, the rain comes and by and by there is a great mass of ice there which tends to force the circle rail out of position and some of it gets on the circle rail, making the table turn hard. We have recently adopted the practice of bolting a short tie on the top of our concrete and placing our rail on that. It is giving us very much better satisfaction, as it gives abundant room between the ties for the ice and snow to work out.

Mr. A. S. Markley:—Don't the ice and snow get under the ties the same as it does under the rail?

Mr. Pickering:—No sir, we have our ties bolted down and have no difficulty with the ice and snow getting under them.

Mr. Swartz:—At our main line terminals the engines handled are the Pacific type. We came to the conical bearing after several years of experience, but had difficulty with that and have now reverted to the ball bearing, similar to that shown in the report. We find that about every 18 months or two years, we have to fix those centers. Either the balls crack and give out, or the frame that holds the balls in position will wear and I have known of instances where the studs have been weighted so heavily that they broke off and allowed the frame to come off and the balls to climb on the frame. We find that the ball bearing center is the most satisfactory. We use air to turn our engines and sometimes 15 lbs. of air will do the work. As to the difficulty of keeping the ice away from the circle rail—we have had that to contend with and we now use the concrete foundation with a wooden tie, running a steam pipe around between the wall and the rail. We have found this a very

good thing as it keeps the ice from settling there. The water all runs to the center and as we have a steam pipe encircling the concrete frame, the water drains away quite readily. Our only difficulty now is to get some center that will stand for a reasonable length of time, as the conical bearings and the discs have never proved satisfactory with us. We have found the ball bearings are perfect, except for durability.

Mr. A. H. King:—My experience has been that if a turntable could be devised without any wheels or circle rail but simply with a bearing that would afford a support when the engine strikes the table so that it is a perfect surface with the rail on the coping, it would be a perfect working table. If the table was out of order so that it becomes necessary to turn it by hand the wheels at the end of the table would be an advantage. I fail to see where a table can be improved in its working by depending in any measure on the circle rail or the wheels on the circle rails, and whenever it has been necessary to depend on those, I have found that the table was out of order so we generally jacked it up and found out what was the matter with the center.

Mr. Edwards:—We were using turntables without any wheels at one time, using simply the bearing plates at each end of the table. We had at that time and still have on our centers a rocker bearing on the saddle casting, and the saddle casting is on conical rollers. This roller bearing gave a space of about 18 inches between the rockers in which the table balanced. We thought that would give sufficient margin to allow the hostler to keep the ends clear of the circle rail in locating the engine on the table, but there was always more or less trouble with that, simply because they would not take the pains to balance the table closely. With heavier engines we have added an end carriage at the free end of the table, that is, the end opposite that to which the motor or electric drive is attached. As far as I know, we are the only road that at any time ever used simply a bearing plate and discarded the end trucks entirely.

Mr. Sheldon:—I think our principal trouble is from the center. arising largly from the neglect of the designer. He has not kept the design of the centers up to the growth of motive power. The rollers and the disc are too small. I have in mind a conical roller center that was built and put into operation, as near as we can learn, about 1870. There were eight rollers built in a carriage, with trunions or axles on each end of the rollers and the carriage

slipped down over this which kept the center line of the rollers in radial lines with the center of the table. That center is turning Atlantic and Pacific type engines today and has been turning engines there ever since that time. The greater part of its life has been where the service was rather light, although at times we have moved it from one place to another. It is now working under a 66 ft. turntable where I think it turns approximately 75 to 100 engines a day, some of them of the larger type. I ascribe the success of that center to the rollers, which are 5½ in. in diameter, but I think they are none too big. The man who designed it was 40 years ahead of his time, because I don't think anybody designs over 5 in. rollers at the present time. I will say that the rollers have worn out one cast iron cage or frame that they run in and we had to substitute steel. This has given us no trouble, which I ascribe to the heavy, strong construction. If we will catch up with our centers, whether discs or rollers, we will have much less trouble. I think that a drawing of that table was submitted to the association 12 or 14 years ago and the same old center is still doing business.

Mr. A. S. Markley:—I did not suppose that anybody had a table without end rollers. We happened to have one that had cages for the rollers. Our trouble began as soon as we put it in and kept up until we got it out. We had to put on end rollers.

Mr. Smith:—In a good many cases we have not had any circle rail at all except under the free end of the table, but where there has been a circle rail or any blocking for that shoe to slide on, there has been trouble just as soon as the shoe came down, because it created the friction which was multiplied by an arm equal to half the length of the table. In some cases it has been impossible to turn engines at all. I asked a conductor one time how many men it took to turn the table and he said that it depended on how many men happened to be in town when the engine arrived.

Mr. A. S. Markley:—I presume that table had a larger center, did it not?

Mr. Smith:—15 ft. radius.

Mr. Penwell:—We have had an old turntable such as Mr. Sheldon described, part wood and part iron, built in 1870. Its center was the same as he described, and we are turning engines on it yet. The wood has been renewed a number of times. The table has been considered ready for the scrap pile ever since I have

known it, and we have not spent a cent on it for a year. Of course it is turning light engines on a branch road, but I am inclined to think, with Mr Sheldon, that the rollers today are entirely too small. The outer ends of the eight rollers under the table I speak of are eight in. in diameter. I have never seen a time when it required over two men to turn the ordinary light engines such as we use on branch roads, and if the table is properly adjusted with the old fashioned hog blocks that are still on it, one man can easily turn an engine. It gives us less trouble than any table we have.

We have a number of tables that have been overloaded. We have three or four tables that require two and one-half to three inches tip to take up the deflection in the table under the engines they are turning—that is, an inch and a half on each end. When those tables get in wind they buckle in the plates in the center of the panels and the stiffeners are slightly sprung. It seems impossible to take the wind out, and while we will all agree that the proper thing to do is to take the table out and put in a heavier one, there are so many of them that one cannot get the appropriations to do what he would like to do. One-half of our turntables should be scrapped and the other half, now under heavy engines, put under light engines. When one turns any heavy engine on a table that has a wheel base within eight inches of the length of the table, he cannot balance the engine without first filling the tank with water and coal which adds weight, and even then it takes several men to turn the engine. The result is that one grinds the center out and secures unsatisfactory results. Our plan now is to change our standard from 80-ft. to 85-ft. and then move the heavier tables on to the branch roads to take care of the light engines and scrap as many as we can get the appropriations to renew.

Mr. Smith:—I want to say a word or two in defence of the engineers who have designed these poor centers. They have been between the devil and the deep sea, like the manufacturers of motor cars. There has been keen rivalry, and as a result, just as little money has been put in as it was possible to make cars for. In recent years some of the railroads have gone to designing their own centers, and I cannot show the comparison between the tables designed by the chief engineers of a railroad and those offered by manufacturers better than by referring to this report. The drawing of the standard turntable of the Chicago, Milwaukee and St. Paul provides for rollers 8½x4 in., a considerable increase in size, both

in the diameter and length of the roller. Many of the roads reported the same trouble as the members here have been reporting today with reference to small rollers, and you will find the following in the report below the drawing just referred to:

"The conical roller centers appear to be satisfactory if properly designed, constructed and maintained. Improper attention to these features has caused much trouble and much criticism of this type of center. One of the principal faults with the design of former conical roller centers, was the small length of the rollers which created unit pressures greater than they should have been. This resulted in the wearing and flattening of the rollers and in the wearing of the rollers into the surfaces of the top and bottom castings. The conditions could be improved by planing the castings, but the trouble usually resulted in the renewal of the rollers and of the castings, practically the entire center, which was expensive. In later designs the length of the rollers was increased and track plates were attached to the top and bottom castings, so that in case of wear the track plates and not the entire castings are renewed. The rollers and track plates should be of hardened steel and the castings of steel.

" In the early designs of conical roller centers no means was provided for keeping the rollers a constant distance from the center although there is a tendency for them to crowd out or to work in on radial lines. Their working in, which seldom took place, resulted in their rubbing on one another with consequent increase in difficulty of turning. Their crowding out resulted in the top and bottom castings coming together and rubbing and in the outer ends of the rollers working against the rough inner surface of the castings with the consequent damage to rollers and castings and increase in difficulty of turning.

" In later designs and more particularly for the heavier tables, means is provided for holding the rollers in line. Some makers do this by placing the rollers in a depression of the bottom casting, the casting being raised at the outer ends of the rollers to make contact with their ends and rubbing takes place here during turning. If the rollers are of steel and the casting also of steel as should be the case, cutting may result if there is any tendency for the rollers to crowd out. The most approved practice consists in the placing of a steel ring, called a live ring, around the rollers, set screws or lugs projecting from the end of each roller or bolts passing entirely through the length of the rollers and through the

live ring; this ring answers the double purpose of keeping the rollers from crowding out and keeps them the proper distance apart. In some designs, especially where bolts pass through the rollers, rings are provided in a similar manner for the inner ends of the rollers, which with the bolts, form a spider."

The point I want to bring out is that the St. Paul center cost approximately $1,000, but it is a center which is considered necessary for a 335 ton turntable by the St. Paul railway. If the railroads are willing to pay $1,000 for such a center or a corresponding amount for a less capacity they will get a good center, but by the time a conical center is designed and built strong enough so there will be no trouble one will have a large number of parts.

" If the rollers work in or out against the live rings the rubbing causes friction that cuts into the metal and increases the difficulty of turning. To overcome this, phosphor bronze frictionless washers or ball bearings are provided in many designs between the ends of the rollers and the live ring."

But it is possible that a center can be designed in which there will be fewer parts and that will cost less to make.

Mr. A. S. Markley:—Is there not danger of getting the rollers too large?

Mr. Smith:—Yes, there is that danger, but it is difficult to say what the roller limit is. The trouble is that they generally get too small. There is very little danger of their being too big.

Mr. Penwell:—I fully realize that we expect things of the engineer that are almost impossible for him to carry out. The principal reason, that of the expense of the center, has already been assigned. If we can get our managements to understand the importance of the center it is money well spent, for there is not only the first cost but also the constant maintenance of a poor center. I think that paving the bottom of the turntable pit will pay. That also is difficult to prove because it may be difficult to show the amount of money saved. I believe it would pay to pave all the pits; in fact I have recommended it to our people to pave pits for turntables that are permanent. I think we should pave the bottom of the pit with brick or concrete and thereby protect the table and at the same time make it much more convenient to clean out the pit. If the shop men have a smooth surface to work over they are more apt to keep the pit cleaned out than if they have rough cobble stones or cinders to work over.

SUBJECT No. 11.

PAINTING OF STRUCTURAL IRON AND STEEL FOR BOTH BRIDGES AND BUILDINGS.

REPORT OF COMMITTEE.

As a number of separate and distinct operations are necessary in the proper performance of a job of structural steel painting it appears best that the subject be divided and the different stages separately presented. Also in this discussion, the process of coating new steel, and the work of repainting old structures should not be confused.

Scientific research and numerous practical tests have demonstrated the fact that certain paint pigments, though possessing excellent moisture repelling properties, will actually stimulate corrosion when applied directly to steel surfaces, while certain other pigments have a tendency to restrict and repress corrosion when used for primers and foundation coats. Because of this we divide the pigments into rust retarding, and air and moisture excluding ones, using the first for priming and contact coats, and the latter, for finishing and exposed outer surface purposes. The pigments used in steel protective paints of the first kind are principally, red lead, oxides and the like, while carbons, lamp blacks, graphite, etc., belong in the other class.

SHOP COATING.

A rust retarding coat may be suitably compounded from red lead mixed with pure linseed oil. The average stock mixture may consist of from 25 to 30 lbs. of red lead to the gallon of oil. This mixture can then be reduced to the proper consistency at the time of application. A small amount of turpentine added to this brush coating, will greatly help in its manipulation and will also provide for proper penetration. Red lead should always be mixed at the time of its application for it settles quite readily, as it is an extremely heavy pigment. If so desired, the settling can be retarded, to a certain degree, by the addition of a small amount of asbestine (magnesium silicate) in the proportion of about 20 lbs. of red lead and 2½ to 3 lbs. of asbestine pulp to the gallon of linseed oil. A small amount of turpentine should also be added to this mixture for the purpose mentioned above. A good workman is required to properly apply red lead paint because of its more or less difficult application.

Natural oxides have also proven to be very good for priming purposes. and very satisfactory results are recorded from their use. A number of consumers favor oxides because of their easier application and the less expert class of labor which is required to apply them. A saving of from five to ten per cent, as compared with red lead paint, can thus be effected. Some concerns are using a combination of red lead and oxide and make good reports regarding it. A number of reliable paint firms have similarly composed products on the market, which are sold under certain trade names, and some concerns have adopted them as their standards.

Although quite extensively used in former years, linseed oil is rapidly losing favor. It appears to be a universal opinion that linseed oil is not a desirable material for the prime coating of metals when used without the ad-

dition of pigments. A foundation coat of linseed oil is very often the direct cause of peeling and blistering of the other several coatings applied over it. The oil is seldom dried enough to insure close adherence to the metal surface which it covers before the other paints are spread over it. When the subsequent coats of paint are spread, the solvents and oils in them are bound to soften to some extent the underlying coat of oil, and the moderate heat of the sun alone is sufficient to cause the whole film to draw up, blister, and finally peel. Too much oil in a paint coating, particularly when the surplus is in or near the foundation coat, will generally cause blistering and peeling, regardless of the pigments used in the coatings. If on the other hand, the erection or final completion of an oil coated structure, should for some reason become delayed, this oil film which deteriorates much faster than a paint coating, will have practically perished, its surface will be morbid and dead and will not have strength and stability enough to carry any subsequent coats, which when applied over this kind of a surface, will also peel.

Field Coatings.

Paints containing the same kinds of pigments as for shop coatings, can be successfully used for the first field coat, providing it is covered with another elastic outer coating. If that is not done, paints suitable for finishing coats should be applied, and the first field coat omitted. Red lead or oxide priming should be darkened for this coat by adding carbon or lamp black in the proportion of 90 to 95 per cent of the reds and 5 to 10 per cent of carbon mixed. The addition of this black will not only help to make the coating more elastic, but will act as a guide to determine if the former surface is being completely covered because of its darker shade and the shade is also brought nearer to the color of the black finish coating.

Carbon, lamp black, and graphite pigments, singly or mixtures of them, have given best satisfaction as outer surface and finishing paints. These, combined with some inert and reinforcing pigments according to special formulas form the basis for nearly every brand of paint for the satisfactory metal coatings on the market. The addition of some high grade gum like "Kauri" improves a finishing paint greatly, producing more elasticity, resistance and life. It is of course just as essential, that the oils entering into the makeup and composition of the various paints are of the proper kind and quality, as that the selection and composition of pigments be properly made and storekeepers or other officers charged with the duties of passing on the merits of goods purchased, should be very alert and strict in regard to linseed oil. Paints containing tar or those with a tar base, should not be used on steel structures exposed to the sun and weather, as tar paint films rapidly check, crack and "alligator."

Repainting.

When for any reason it becomes necessary to repaint an iron or steel structure, the paint should never be applied in wet or freezing weather, and the surface should be freed absolutely from all scale, rust, dirt, etc. It is not sufficient to merely apply a fresh coat of paint over an old paint surface under which traces of paint corrosion appear, for while the new paint will cover up the old surface, and may adhere firmly to it, corrosion goes on beneath the paint just the same. Freeing from rust and corrosion and perfect cleaning are positively necessary. When for some reason, it is not possible that the entire structure can receive a coat of some rust retarding primer, the parts cleaned and freed from rust, and all the exposed surfaces, at least, should be touched up with either a red lead or oxide primer, before the finishing coat is given. The use of turpentine, in the paint applied over the old surface, is advised, as turpentine is a penetrant, providing the penetration and adhesion between the old paint film and the new coat.

Although more expensive cleaning by sand blast is much more thorough than the hammer, chisel, scraper and wire brush method, and the greater cost is readily offset by better results in the end. The sand blast

method thus far has not been very extensively used, so the committee has not been able to gather full data as to the cost, etc., but we believe that the matter is worthy of deliberate consideration. Where the steel has been cleaned with the sand blast, and promptly painted, it has not shown signs of corrosion again nearly as quickly as steel cleaned by hand.

Occasionally we notice defects showing up here and there on a steel structure within an unusually short time after the completion of the painting. On looking into the matter we find that nothing extraordinary has occurred during the progress of the work. Everything has been handled in the usual way, the general course of mechanical procedure has been followed, and still improper results are appearing. We recall no acts of our own to which to lay the blame and are finally compelled to look for the cause previous to our own handling of the work, or to the priming which was done at the works or in the mill. We are not certain beyond a doubt, so we decide to visit a mill, and there make personal observations which may very probably result as follows: In one part of this enormous plant we find the inspector busy in the pursuit of his duties checking, comparing specifications, testing, weighing, and attending to the many details connected with his work. In the meantime we notice in another remote part of the place a bunch of unskilled laborers mopping paint onto some steel that had been sent along for priming, using large 6 in. or 8 in. flat brushes, and covering over mill scale, rust, dirt and other imperfections, each and every one a destructive agent and an enemy to the life of steel. We observe all these stimulators of corrosion brushed over and covered up with paint, but not removed, and so the march of the corroding process is sure to go on. We next pay attention to the paint they are using and learn that the package which was opened some time ago to be inspected, and was left standing uncovered all this time, had contained the standard paint as specified, but now through neglect to properly cover, is no longer fit for the purpose used. On examining the contents of the package closely, we also notice that the paint is scarcely stirred up, and we see that the oily substance from the top of the mixture is first used, and as the work progresses and the material is consumed, the paint becomes heavier and intermixed with more or less pigment, until when the lower part of the package is reached nothing is left but a semi-dry pigment, which will no longer spread under the brush. Now, to assist in brushing, the men reach for the benzine can, and reduce the paint with it, destroying what little life the paint had first contained. In this way, a number of different surfaces and films are created, on the same structure, and from the same package of the so called protective coating.

We proceed further, and find at other parts of the mill, though this time under a covered shed, more laborers applying a shop coat to other sections and parts of the structural steel. Here we notice exhaust pipes of all kinds steadily discharging vapor and moisture which finally settles and deposits on the steel. Under such conditions the steel cannot be perfectly dry, however much it may appear so, yet the painting is done just the same, these layers of moisture are enclosed between the surface and the steel, and the paint which is supposed to close the pores, and firmly adhere to the steel, is merely attached in some places and spots, and a weak foundation is created, which is absolutely unfit to receive and successfully hold subsequent coats of paint.

While we have gathered all this valuable information, the inspector has found an opportunity to inspect the painting on these various sections of the steel. He looks at the job, and as it looks uniform in color, he regards it as properly done, because it is outwardly covered over with paint. The material is consequently passed, loaded and shipped.

The foregoing illustration may appear somewhat severely drawn, and the situation presented, greatly exaggerated, nevertheless, if a number of troublesome cases were thoroughly sifted, the illustration, in part, or in whole, would be identical with the underlying cause of the trouble.

It must not be construed that our illustration is intended to cast any reflections upon the inspector or his methods. On the contrary, it is sought

to imply that he uses his principal efforts in a direction considered primarily important, which is, the correct fabrication of the parts composing the structure. No matter how diligent and untiring an inspector may be, it is not possible for him to be in a number of places at the same time, for, in large plants, where modern methods are pursued in the manufacture and assembling of steel, the various departments are sometimes miles apart.

Of course, not all failures are due to work which was first painted at plants, for often even among so called intelligent mechanics, the belief still exists that anything in the way of paint is good enough for priming purposes, so long as it is going to be covered again with paint, thus entirely ignoring the fundamental principles of a correct foundation.

It may, therefore, be suggested that considerable attention be given to the education of men who deal in, or supervise the erection and maintenance of steel structures, so that greater interest in the problem will be aroused, better coöperation between the various departments effected, and the proper men chosen to handle the different lines of work.

CHAS. ETTINGER,
R. H. REID,
E. E. WILSON,
O. F. BARNES,
O. F. DALSTROM,
Committee.

DISCUSSION.

Mr. C. Ettinger:—The committee was unable to cover the subject as fully in this report as some of the other subjects have been, as the progress in the outlined does not seem to have reached the stage where we can report entire satisfaction. The greater part of the report is necessarily devoted, therefore, to a consideration of evils.

Mr. Killam:—I would like to ask the chairman what virtue there is in lampblack mixed with paint, beyond giving a coloring or tint?

Mr. Ettinger:—If one takes a pound of lampblack and a pound of any other pigment, such as red lead or other oxide and grinds them in oil, he will find that he can squeeze 35 per cent more oil into the pound of lampblack than he can in the oxides or any other pigment of that kind. It is universally conceded that the oils, combined of course, with pigments, are the things which preserve our structures. The elasticity in the oil is the property that does the work. You have undoubtedly observed station signs coated with lead on which the name appears in black letters, where the letters which were repeatedly coated with black on top of the white lead are actually embossed and are standing out. Time and again the elements have worn away the white lead, but the black has remained and built up this higher

surface, proving beyond a doubt that black of that kind or the pigments which take up the most oil are the pigments to use for outer coatings, because they contain more elasticity. With steel moving backward and forward, the expansion and shrinkage will surely be taken care of better by an elastic surface, than by a surface that sticks closely to it and is bound to crack and check.

Mr. Killam :—Our line runs through a country of varied temperatures and I have found that the temperature of a country has very much to do with the elasticity and lasting qualities of the paint. We have, for instance, a draw bridge across the Strait of Canso, certain portions of which are dipped once or twice a day into the salt water. Different kinds of paints have been tried here, some lasting a year or two and others a very short time. The chief engineer got up a preparation of red paint and lampblack and ordered that put on the draw. We had a contractor do the work and I got him to paint one side of the beams that dip into the water with this formula of red paint and lampblack, and the other side with Walter Carson's Anti-Corrosion Paint, manufactured in London, England, and used on the warships. The next year, the side that was painted with lampblack and red lead was practically exposed while the other side painted with Carson's lasted two years. On some of our bridges, such as the one across the Grand Narrows, the salt air and the fogs come up along the bottom chords of the bridge and take the paint off in two or three years. This is one of the places where we test paints, by painting pieces of steel and hanging them over the side of the bridge. I examined some 37 pieces last year, only about four of which were in such condition that I could tell what kind of paint was on them; the others were all rusted and gone. Take the same kind of paint and use it inland as in Quebec, where the climate is dry, and it will show that the climatic conditions existing where these structures are built, has as much to do with the life of the paint as the quality of the paint itself.

Also there is no question but that the cleaning of the steel before it is painted materially affects the life of the paint. We have had work done by contract and I have found pieces blistering up as big as one's hand within three weeks, in which cases I have refused to pay any money until the contractor cleaned the bridge, scraped the paint off and gave it three coats of paint where he needed only to give it two in the first place. I have

known of bridges similarly situated, which had been neglected until the steel along the side where the water floor was, was pitted so that a sand blast would not touch it and nothing would clean it but a hammer and cold chisel. It is one of the most particular and one of the most difficult things to get bridges, particularly along salt water, painted so that the paint will stand the test.

Mr. Ettinger:—How great a pressure did you have when you tried to clean off that scale with the sand blast?

Mr. Killam:—I do not know the pressure exactly, but it was a machine made by Fairbanks, Morse & Co., and guaranteed by them. Ordinarily, it did its work, but there were places where it would not, because the scale on that iron was harder than the iron itself.

Mr. Ettinger:—Those scales are usually loose.

Mr. Killam:—But when one gets them off, there is a hole in the steel where they come off.

Mr. Ettinger:—About three years ago I painted a structure, under the worst conditions one could imagine. The bridge had an open I-beam floor, with trains passing below on an average of about every seven to ten minutes. Stockyards transit and other trains were passing above about every twenty minutes, dripping their brine and other corrosive agents. The height between the smokestack of the locomotive and the bottom of the I-beams, was not two feet, so one can see that we had exceedingly severe conditions. We found scales on those I-beams that were ⅜ in. thick by actual measurement. The sand blast cut through those quickly, but it required 70 lbs. pressure per square inch to do it. We tried a 20 lb. machine at first, but it acted like yours.

Mr. Killam:—The bridge I refer to is 650 ft. long, with a 225 ft. center span. We had a good deal of difficulty patching it from time to time, but a contract was given a sand blast company to paint that bridge. We had a man stay on the bridge to see that everything was properly cleaned.

The President:—Does anyone else wish to speak on this question of painting bridges and structures? It is a live subject. I am sure we all have our troubles in that direction. I would like to hear from members from different parts of the country, so as to get more varied information.

Mr. Pickering:—I have been listening with a great deal of interest to the discussion. It occurs to me that it is not so much the difference in the temperature that affects our paints on

bridges, as Brother Killam says, as it is the location of the bridge. The major portion of my territory runs along the seacoast and in many places the line is very near the coast. I have another portion of the division which runs up in the mountain districts at a high altitude. I find that the bridges along the coast will need painting about twice, while the ones up in high altitudes only require it once, using the same kind of paint, with the same men putting it on. For this reason I am inclined to think that it is not the changes in the temperature or the kind of paint used, as much as it is the location and the local conditions which affect the paint.

As to the kind of paint used, I am not a chemist and I have not studied deeply enough into this subject to say what I think is best. We are bound to one standard on our road and we use that. I was amused at one thing that was said in regard to lamp-black. I want to bear out what Mr. Ettinger said, for just last week I noticed an old sign on a discarded building, which was hard to read except for the fact that the letters were embossed on the sign by the black paint which had been applied on the letters. They had probably been painted over two or three different times. I put my rule flatly on the sign and found that those letters were raised in places more than 1-16 in. above the body of the sign, or, in other words, the body of the sign had worn away; but the black paint had preserved those letters and the surface of the board was nearly as good as when they were first painted. It occurred to me that there might be something in using lamp-black.

Mr. Killam:—Someone mentioned using benzine in paint. I would like to know if anyone has used anything of that kind in paint for a dryer?

Mr. Ettinger:—Benzine is not used for a dryer, but is used to cut the material. It is one of the solvents that is used a great deal today. The illustration was merely one to bring out the fact that a great many things are done behind our backs that we don't know about. One will find in this report that the application of turpentine is recommended. That is highly injurious if one uses too much of it, as it destroys the life. Instead of only cutting to produce penetration to enable the paint to get in and bind to the surface, it causes a great deal of trouble with blistering, cracking open and finally falling off. Behind that, one will find a thick film of rust. I can show photographs of an oil-

coated structure erected before the World's Fair of 1893 which had been repainted and repainted until, within the last two years, the entire scale of paint is coming off and hanging down. Behind that there is a scale of corrosion and rust thicker than the paint film. The paint appears all right on the surface but by and by this shrinking effect produces a cracking in the paint film, so that it finally separates and drops off and reveals the trouble behind. Many of our troubles today are due to something we can't see; therefore, we must be very careful in the first preparation. A great many of these defects are due to shop coatings. Very few of us know anything of what has happened before we handle the structure in the field. In six months or a year, sometimes sooner, we find trouble appearing, and forget that some work was done previous to our handling of the structure; consequently, we blame ourselves and try to find the cause of the trouble.

Mr. Alexander:—We all know we take chances in shop painting but the work is not all bad. We had a certain bridge company erect a number of large bridges for us one year and the contract provided that this company was to paint the bridges with two coats after they were up. They erected the bridges in a season when the weather was dry and warm and painted them with two coats of paint in addition to the shop coat, which was already on the chords and other built-up members. They did their work well apparently. I was inspector on the bridges and I could find no fault with the way they were doing it. However the next year those bridges commenced to peel and blister on the built-up members so that they had to be scraped, which cost more than if they had never been touched. We received another bridge after that from the same concern, which they erected in the winter time. The bridge was received with a good oil coating on it and we told the bridge company that we didn't want it to paint any more bridges. We thought we would paint it ourselves. We didn't paint it when it was erected but waited until the next summer, when the season was suitable, when we gave that bridge a good coat of graphite paint with our own painters. As it had a good oil coat before, we didn't give it two coats of paint then. That bridge stood for six years and was in good condition. We then gave it another coat of paint and it stood five years longer without touching again. This was good shop work.

It was voted to allow Mr. Coleman, a member of the American

Society for Testing Materials, of Cleveland, the floor for a few minutes to address the convention on the Theory of Corrosion on Iron and Steel.

Mr. Coleman:—I assure you that I appreciate very much the honor of addressing you, not as the representative of any firm nor as the representative of the American Society for Testing Materials, but purely as a party who is as much interested in the prevention of corrosion and the production of goods to prevent corrosion as you are, both from a practical and scientific standpoint. I have had several years' experience, both in the manufacture of paints and in scientific research, and I am frank to admit that I have never yet seen a scientific investigation that was worth anything without being practically proven by actual tests. The work that I refer to more particularly is work that was started a few years ago by the Institute for Industrial Research in Washington for the purpose of ascertaining what caused rust, and to prove by practical tests the soundness and the value of the different theories that have been exploited for some time past. The theory generally accepted is that rust is caused by electrolytic action.

I know that this morning several things were referred to regarding electrolysis, where live electrolysis was causing rust, but I do not refer to it in that sense, I refer to electrolysis in this case from a chemical standpoint. It is known that when two metals of opposite nature come together, there is a flow of electricity between the two; and dividing these metals into two classes, positive and negative, we always find that when there is a flow of electricity between two metals of that character, the positive metal goes into solution. Iron is one of the most positive metals we run across in ordinary, everyday life. The fact that rust is a combination of iron, hydrogen and oxygen, brings us to the assumption that hydrogen is much more negative than iron. It has been proven that iron must first go into solution in order to rust, that is, become dissolved in water, and we know that we cannot have rust without water.

Up to the present time I do not believe that any paint manufacturer or private individual has found a paint that is an absolute excluder of moisture. Some way or another, in time, it gets in underneath the paint coat, and there, in the presence of hydrogen, which is always present in water in the free state, and in the presence of acids, alkaline pigments or materials of that character, iron goes into solution, oxidizes and becomes rust. That is the basis of the electrolytic theory. The iron first dissolves in water

and there combines with both hydrogen and nitrogen,—the elements of water,—forming rust. The object of my work was to ascertain, if possible, if some method could be devised to prevent this rust. It was found that if certain materials were brought in contact with the iron, which would prevent the formation of hydrogen, they would prevent rust. Hydrogen has an acid character. It is a product that is the base of all acids, so that wherever you have hydrogen, you would naturally expect acids to be present. Thus my first preventive for rust was to use some alkaline pigment. Red lead is one of the most active alkaline pigments we have, and you can readily understand why red lead is such an efficient preventative of rust from the fact that it prevents the formation of hydrogen next to the iron, and without the formation of hydrogen rust cannot form. As a next step it was determined to prevent rust by producing over the coat of the iron some other metal which would render the iron immune to electrolytic action. It was found that certain soluble salts or chromates would prevent iron from being attacked by electricity and while coated with that product there would not be any electrolytic action. Inasmuch as iron always contains iron, manganese, carbon and other materials, there is a constant flow of electricity between them; so the use of zinc chromate, which has lately come into use, has been found very efficient as a rust inhibitor. Test fences at Atlantic City have shown that the old-fashioned vermilion, which is the basis of chromate of lead, was the most efficient rust inhibitor of any pigment and has absolutely prevented the steel from showing any signs of corrosion whatever up to the present time, after two years' exposure. The next matter is to put some metal against the iron which is positive to iron, and in that way, where there is an electrolytic action, that metal will go into solution instead of the iron. I understand that the Pullman Company were using copper and other metals in their window sash, at one time, with the result that the steel of the steel cars went into solution. They changed over to the use of aluminum, for those parts of the window sash that came in contact with the iron, because aluminum is more positive than iron and will go into solution quicker. Just how long they have found the window sash will last I do not know, but it does prevent the corrosion of the steel. The next thing is to have a paint next to the steel which contains a rust-inhibiting pigment in some form which is alkaline—as red led, blue lead, orange mineral and things of that character, or such things as graphite and lampblack, which

are very valuable, but not so valuable as those pigments which prevent the formation of rust by some of the means I spoke of before. If the mill scale and things of that character are not removed the product is hydrate of iron and it is electro-negative to the iron itself. Mill scale is also electro-negative to iron itself, so that if rust exists underneath the paint, even though the coat of paint be of a rust-inhibiting character, the existence of a constant current of electricity underneath the paint between the iron and the mill scale will force additional iron into solution, and corrosion will go on underneath the paint without any hindrance whatever. Wherever moisture can get through, corrosion will continue. The necessity is first to have everything that is negative to iron, such as rust and other metals, removed from the surface of the iron and then use alkaline red, blue red or something of that nature or some form of metal which will prevent electrolytic action, such as zinc chromate or American vermilion.

SUBJECT No. 12.

RELATIVE MERITS OF BRICK AND CONCRETE IN RAILWAY BUILDINGS AND PLATFORMS.

REPORT OF COMMITTEE.

The scope of this subject is so broad and the conditions that would tend to determine the merits of either of these materials for any particular place or purpose are so varied that at best only general conclusions can be made. With a view to securing information as to the practice, experience and opinions of the members of the Association and especially those engaged more particularly in building work, a circular letter was sent out and in attempting to systematize the matter, the following general classes of buildings were chosen:

(*a*) Passenger stations, including in this class combination passenger and freight stations.
(*b*) Freight stations.
(*c*) Warehouses.
(*d*) Engine houses.
(*e*) Shops.
(*f*) Interlocking towers and similar structures.
(*g*) Oil houses, tool houses and other small structures of this nature.
(*h*) Other buildings.
(*i*) Cinder pits.
(*j*) Platforms and walks.

While it is evident that each of these classes has points in common with the others, yet each has certain dominating features that serve to differentiate it from the others in determining the choice of materials to be used. There are admittedly other classes of structures, and there are embraced within the first class of buildings, especially, a multitude of styles and a variation of conditions of use, as great, almost, as the differences existing between any of the classes chosen that might influence the selection of material for construction.

Aside from local conditions the following are of most importance in determining the relative merits of brick and concrete for use in any of the above classes of structures:

1st. Comparative cost, both in construction and in maintenance.
2nd. Safety.
3rd. Durability.
4th. Fire resisting qualities.
5th. Susceptibility of alteration.
6th. Adaptability to architectural treatment including the feature of artistic design.

Here again the list of factors that govern in choosing the material for any particular instance might be extended indefinitely and a factor that would practically control the situation in one instance, might be a negligible quantity in another case.

The Committee attempted to collect information regarding the practices with respect to these matters, and to ascertain as far as possible any results either satisfactory or unsatisfactory that would tend to show the

merits of either of the materials to meet the varying conditions imposed upon them in the different groups of structures.

Economy is, of course, the most important consideration and with the increased standardization of structures throughout the country the more permanent structures, generally, prove the most economical. If cheapness of first cost is the controlling factor, or if structures are of a temporary nature, wooden structures should be used. Wooden construction is still the cheapest in all instances, except perhaps on isolated roads so far removed from the sources of timber supply that freight charges make the cost of lumber approximately equal to that of other materials. It is not, however, considered that this subject embraces anything other than a direct comparison of the merits of brick and concrete to meet such requirements as either may be used for and, therefore, any application of one material to uses wherein the other is totally excluded is not considered. As both of these materials are adapted generally only to permanent construction, we have considered this subject as confined to permanent structures.

PASSENGER AND COMBINATION PASSENGER AND FREIGHT STATIONS.

As was stated before, each class of buildings has points in common with the other classes, so that all common points will be treated under this head and only those points applying to individual types will be discussed in the remaining classes.

Either brick or concrete may be used with satisfactory results in the construction of passenger stations. Brick has been in successful use for many years while the use of concrete has been steadily growing for several years. For foundations of all kinds concrete is superior to all other kinds of material as it is cheaper and stronger. By the use of reinforced concrete the bearing area may be increased when necessary without great additional expense. For walls above foundations there is not much difference in cost between plain concrete and good brick construction for the ordinary sizes of station buildings, costing up to $15,000 or $20,000. For one story buildings of this size and where not more than one building of the same size and shape is likely to be erected in any one season on the same division there is little opportunity to effect any economy by using the forms over again.

Where variety of design is desired this can be effected by a combination of brick and concrete in the walls, using concrete for the frame, columns, etc., and brick for the walls, pilasters and general decorative treatment. There will be little if any excess cost in this type of construction and very pleasing results may be obtained. Several railroads have used this type of construction to a limited extent with good results. Care must be taken to maintain good proportions by not allowing too much exposed concrete and to make a judicious selection of colors to obtain pleasing and harmonious results. The building must likewise be adapted to its environment to give complete satisfaction.

Buildings having solid monolithic concrete walls are harder to heat in cold weather than if built of brick, even though air space is provided by furring on the inside. Special precautions must be taken to secure good ventilation to avoid dampness for in wet weather concrete absorbs a great deal of moisture which gives the structure a rather disagreeable appearance. A great deal of dirt will accumulate on the outside walls at such times and much permanent discoloration results. In dry climates this objection does not exist to as great an extent and for this reason as well as from the fact that the natural color of concrete harmonizes with the landscape in dry countries, concrete gives better satisfaction in such climates.

Monolithic walls can be constructed with air spaces and insulation in the walls so that dampness may be kept out and less difficulty is experienced in keeping the rooms warm, but such construction is expensive and not in general use. It could not be recommended for buildings of this type.

Another type of construction that has given good results is the con-

tinuation of the concrete wall above the foundation up to the height of the window sills and the use of brick above. This much of the wall is generally plain and is not cut by openings other than doors, so that it needs no ornamentation or finish. It can be constructed comparatively cheaply and should be placed at the same time that the foundation is placed. This can be recommended as good practice.

The unit construction system or the process of casting walls in sections in moulds laid on the ground and afterwards placing the sections in position by means of a derrick is being developed. It is especially suited to one story structures of large area and of such nature that the walls can be designed to consist of a number of bays of the same size. This method has not as yet been adopted for structures of the size and type of passenger stations, and does not appear to have any advantages for ordinary construction of this type.

On the Wabash Railroad small passenger stations have been constructed in which the walls are built of solid concrete to the bottom of the windows and of frame with cement stucco finish above this. This type has been reported as giving good satisfaction in this class of buildings. Owing to the lightness of the super walls the concrete above the foundation is only nine in. thick. The cost of such a building does not greatly exceed that of wooden buildings having equally good foundations and other features to correspond. Plans of this type and cost as estimated by Mr. A. O. Cunningham, chief engineer of the Wabash, are included in this report. This building possesses the merit of being more nearly fireproof than a frame building. If appearance is considered care must be taken to select a roof in harmony with the

Concrete Passenger Station at Gary, Ind

walls. On the Wabash metal shingles are used and with satisfactory results. A building of this type 18ft.x42ft. costs about $1400 exclusive of platform.

Concrete blocks properly made can be used to advantage in buildings of medium size. When walls of one thickness of blocks are laid up, the cost is a little less than the cost of brick. The cost of buildings of this sort will be about 30 cents per superficial foot when blocks 8 in. thick are used. There are limitations, however, to this type of construction and to be most economical the building must be designed so that all dimensions shall be multiples

of the size of the blocks used. This type of construction can be carried on in cold weather as well as brick work. Plain blocks having flat surfaces give more pleasing results artistically than blocks moulded in imitation of stone. Concrete blocks cannot be made to look like stone and any attempt to do so results unfavorably. Concrete blocks are subject to discoloration the same as monolithic work and from the standpoint of appearance brick work is superior. Otherwise there is not much choice between the two for use in moderate sized plain structures.

For use in larger buildings, the cost of which exceeds $50,000, splendid results have been obtained by the use of concrete throughout the entire construction. The Lake Shore and Baltimore & Ohio depot at Gary, Ind., is an example of such construction. Such results as were here obtained could not have been secured had brick been used. In this particular concrete passes beyond the field of brick and enters the realm of stone as a building material. This example, however, should stand as an encouragement to the use of monolitic concrete in less pretentious structures.

From the standpoint of safety there is no difference between the two classes of material for use in the walls of passenger stations provided perfect workmanship is exacted in both cases. There is greater danger at the present time of defects in concrete than in brick walls due to lack of experience on the part of the workman, so that when concrete is used thorough inspection must be maintained and the work entrusted only to foremen who understand thoroughly the nature of concrete and how it should be handled. Many of the poor results obtained where concrete has been used are attributable to improper handling of the materials. Owing to the fact that concrete construction has not been carried on long enough, foremen and workmen thoroughly competent to handle it are scarce, while not so much difficulty is encountered in securing competent bricklayers. This condition, however, should not act as a deterrent against the persistent adaptation of concrete to all its possible uses, but should incite caution in the minds of those who contemplate new departures in its use and should impress upon them the necessity of a thorough understanding of all the principles involved in the work to guard against disaster.

From the standpoint of comparative durability there is no choice between concrete and good brick. Concrete in itself would undoubtedly outlive brick in large masses, yet owing to the numerous other factors that determine the life of a building of this sort either material will answer equally well.

The comparative fire resisting qualities of concrete and such brick as may be used in building work is somewhat a matter of conjecture and depends upon the character of the fire. If a building has wooden floors, ceiling and roof timbers, a fire originating on the inside would completely destroy the building in either event. If the building is practically of fireproof construction throughout, a fire such as might occur in the ticket office furniture would not damage either materially. Either type would act equally well as a fire retardent from fires originating outside of the building. Slight fires might be liable to cause the surface of the cement to scale off, whereas brick would not be damaged at all.

Concrete work is not subject to extensive alteration and where alteration is a possible factor of importance brick is preferable.

Considerable has been said about the qualities each of these materials has that lend themselves to architectural treatment. There is no material superior to good brick for use in securing plain, durable and dignified effects. The proper arrangement of brick to give a good appearance to a building need add no expense to the construction. The beauty of many brick stations has been destroyed or seriously marred by the erection of ungainly platforms around the building proper and it is needless to add that if the surroundings of a building are not made harmonious with the structure itself any effort bestowed upon the building will be fruitless. Brick possesses the advantage of many fine colors that lend themselves to varied treatment. Generally speaking the darker and softer colors are most readily adapted to most situations and are never injured seriously by the smoke and dirt that are un-

avoidable about railroad stations. The lighter colored bricks likewise give good results when properly chosen. They seem to be best suited to plain treatment in larger buildings when good straight line effects may be had.

Concrete takes its beauty from its appearance of strength and solidity. Its architectural treatment should be confined to plain surfaces, straight lines and arched effects over doors, windows, etc. Paneling can be used to advantage in some places. Where covered platforms are necessary much better effects can be secured if the sheds are supported on concrete columns arched over to support the root, so that they have the appearance of a continuous part of the building. If concrete is used care must be taken to avoid placing any ironwork in such position that rust can be carried therefrom over the surface of the concrete by rain for if it is serious discoloration will result.

No attempt should be made to add elaborate details such as ornamental friezes, cornices or capitals to small or medium sized stations. This style of ornamentation adds materially to the cost of the structure and does not improve the appearance. Ornamentation of this character is effective only in larger buildings where massive column effects and other features of this nature can be secured in good relative proportions.

FREIGHT STATIONS AND WAREHOUSES.

For freight stations and warehouses many of the principles applying in passenger stations are found. There is one essential difference, however, in the fact that the buildings are usually larger. Here again brick has been in successful use for many years. The latitude for using concrete, however, is wider than in passenger stations. For foundations concrete is preferable in all cases. For one story buildings reinforced concrete can be used with advantage in columns and girders, while thin curtain walls of brick or cement plaster on metal lath are especially suitable. The unit form of construction is well adapted to this class of structure.

The chairman of your committee would call attention to a concrete warehouse of the Universal Portland Cement Company located on Elston Ave. just north of North Ave. in Chicago that was built in this manner. It is well constructed and probably could not be excelled for this type of construction. The particular advantages of this type of construction are that the units can be cast in these moulds at less expense than in forms erected in place.

If the sections are allowed to harden and cure thoroughly as they should be before being erected there will be no possibility of their cracking as might occur if the concrete is poured in place. The units are securely fastened together when erected. Although requiring a somewhat different equipment, the method of erection involves practically the same operation and costs the same as elevating the wet concrete to pour it in forms erected in place. The fact that the entire side of the mould is open allows more careful placing of the concrete and reinforcement in the thinner portions of the walls.

If it is desired to use concrete floors and roof construction, the columns, frame, pilasters, beams, etc., should also be constructed of concrete. The curtain walls may be either of brick, hollow tile, reinforced concrete, or concrete plaster on metal lath. The latter, however, could scarcely be recommended in buildings when all other parts are of heavy concrete construction as the saving in curtain walls would be a doubtful economy. If wooden floors and roof construction are used, there is little choice between brick or concrete for the walls.

ENGINE HOUSES.

The factors that determine the choice of materials for engine house construction are the same in some respects as they are in other buildings. The experience of most roads has been that their engine houses have been out-

grown and have had to be replaced on account of inadequacy to meet conditions rather than to decrepitude, so that while this condition may not continue to be true of the future to so marked an extent, yet the factor of durability of material is secondary to first cost.

Considerable progress has been made in the construction of engine houses entirely of concrete. When it is desired to go to the expense of making the house essentially fireproof by making the roof, girders and posts of concrete and the use of metal sash and fixtures, as much as possible, then without doubt the balance of the construction should be of concrete. Some objection has been raised to concrete being used in the outer wall on account of the damage that may be done if an engine should accidentally run through. This need not be considered except that the wall should be so constructed that if this should happen the damage would be confined wholly to the curtain wall and would not extend to the pilasters or beams supporting the roof. If this is done, no greater and probably not as great damage will be done as would occur in a house having brick in ordinary construction in the outer walls. Where concrete is used more opportunity is given for window spaces in the outer wall. As a matter of fact, the entire space between pilasters down to the level of the tracks has been and may readily be utilized for this purpose, as the roof support can be carried above the windows from pilaster to pilaster by means of beams. This form of construction gives room also for considerable economy in the foundation concrete between pilasters. Care must be exercised in designing houses of this kind to properly proportion the foundation to withstand the jarring action of the locomotives passing in and out of the house. The foundations and pits for all classes of construction should undoubtedly be of concrete.

If the interior and roof construction are to be of timber the outer walls above the foundation or at least above the bottom of the windows can be built of sufficient strength more economically of common brick than they can be of concrete. It will be advisable from the standpoint of safety to construct fire walls in houses of this type of more than 15 stalls. These can be built more economically of hollow tile although brick is generally used. When the construction is fireproof throughout fire walls may be omitted although they will be of advantage in the warming of houses, especially, if they are heated by the hot air system. It is needless to state that greater economy in the use of concrete can be effected in the largest houses admitting of using the form lumber several times.

SHOPS.

Reinforced concrete is particularly well adapted for use in the construction of shop and power house buildings. Either plain or reinforced concrete should be used throughout for foundations, both for the building proper and for the machinery. If the most durable fireproof buildings are desired reinforced concrete should be used throughout the entire construction. A peculiar advantage possessed by this type of construction lies in the freedom from vibration caused by machinery. In one story buildings, especially, curtain walls may be constructed of cement plaster that will answer the purpose as well as solid construction and at less cost. Here also the unit construction method can be followed to advantage as buildings of this class will naturally be designed in bays of identical proportions.

Hollow concrete blocks have also been used to advantage in shop and power house construction. The air spaces in the blocks serve the very useful purpose of keeping out moisture and retaining the warmth, and thus overcome to a great extent two of the most objectionable features of solid concrete in building construction. For buildings of any great size the blocks should be larger than the ordinary blocks and of heavier proportions throughout. The design of the building will determine the proper dimensions, but for walls 25 ft. or more in height the blocks should be at least 12 in. thick. Monolithic foundations should be used and also either monolithic

pilasters should be adopted or solid blocks used to properly carry the load at points where girders and beams are supported. If the blocks are made on the job they can be cast solid. Where some ornamentation is desired window sills, lintels, copings, arches, etc., can be cast solid in moulds with good effect and the walls may be bush hammered. This adds to the cost, of course, but may not be inconsistent. The circumstances in each case and the effect desired should govern the treatment. The Committee considers it proper to recommend that attention should be paid to appearance and proper treatment given in each structure built no matter for what purpose to secure a dignified harmonious aspect, but it does not recommend any "gingerbread" work.

It is our opinion that in the matter of cost of buildings of this class that the outer walls can be built cheaper of common building brick costing from $6 to $8 per thousand and that the use of brick is safer if we consider the possibility of danger from poor workmanship. By the use of concrete foundation, brick walls and cement tile roofs, supported by steel trusses results as satisfactory as could be desired can be had.

For floors in such buildings neither brick nor concrete has proven entirely satisfactory. Creosoted wooden blocks on a concrete base are being tried and seem to be proving satisfactory. In some cases second hand bridge timbers have been cut up and used on a sand or cinder base. These give good satisfaction while new, but do not last as long as could be desired. Mr. Riney, foreman of bridges and buildings of the C. & N. W., who has had a lifetime of experience in this work, recommends wooden blocks on a concrete foundation with a sand cushion between as the most satisfactory type of floor in shops and engine houses.

INTERLOCKING TOWERS.

For interlocking towers either concrete or brick may be used to good advantage. For this class of buildings the most economical construction seems to be the use of solid columns at the corners and light curtain walls between. Concrete is well adapted to this purpose although brick may be used in the same manner. The importance of fire-proofing interlocking towers is a strong factor in their construction and is receiving more attention than formerly.

OIL HOUSES, TOOLHOUSES, ETC.

Buildings of this class can be constructed of either material. For the smaller sizes cement plaster is recommended as preferable to either brick or concrete. Its cost is less and it answers every purpose equally as well as the most expensive solid construction. Cement blocks of the ordinary building size have been used and while good results are obtained, they are more expensive than necessary. For larger oil houses and store houses such as are ordinarily required at important division headquarters, heavier construction is necessary and should be either of brick or reinforced concrete. The floors, foundations and roof should be of concrete, while there is no choice between the two materials for the walls.

OTHER BUILDINGS.

In the construction of office buildings, grain elevators, docks and other structures no general rule can be applied. Concrete is coming into favor for use in the construction of elevators and docks. Brick has never been used to any great extent in either of these cases. All kinds of materials have been used for office buildings but brick is still preferable. There is nothing peculiar about a railroad office building that would differentiate it from any other office building and local conditions and practice will govern largely in the selection of material.

CINDER PITS AND TURNTABLE FOUNDATIONS.

For this class of structures concrete is preferable under ordinary circumstances. Cinder pits should be paved with a good fire resisting brick. Brick will not only withstand the effect of hot cinders and the water used to quench the fire for a longer time, but may also be renewed when it gives out. Cinder concrete has been recommended as not subject to so great disintegration as stone or gravel concrete when subjected to these conditions, but it is the opinion of the Committee that the safer method is to pave the pit with brick. Whether or not the sidewalls should be lined with brick depends upon how severely they are likely to be heated. This will depend upon the size of the pit, and upon whether or not the cinders can be removed before they pile up against the walls. Brick for the entire construction of cinder pits could not be recommended.

Turntable walls and center piers should not be built of brick. Concrete is suitable for this construction. If the pit is to be paved it may be done either with brick or concrete. One feature of turntable construction to be considered is that in the past it has been frequently necessary to replace tables that have become too short before their full life is secured, thus necessitating the construction of new circle walls. If this is anticipated concrete should not be used. In this event it would be better to build the wall of rubble masonry.

PLATFORMS AND WALKS.

For walks the accepted practice where the walks are used almost exclusively if not wholly by pedestrians is a five or six inch cement concrete on a cinder base constructed in accordance with ordinary sidewalk specifications.

For platforms there seems to be a great diversity of opinion. The two principal objections to concrete are that when wet it is slippery and consequently more or less dangerous and that when cracked by frost, falling baggage or other causes it is difficult to repair.

One objection to brick is that a brick platform is likely to become uneven and may cause passengers to stumble and in this way be dangerous. Another is that it is harder to truck over on account of its greater resistance to traction and is more likely to shake baggage off the trucks.

There are three general types of construction in general use in the construction of what may be called permanent platforms.

1st. Vitrified brick on a gravel or cinder base. This base should not be less than 6 in. thick and should be as much as 12 in. under some conditions. Platforms of this type can be built for nine cents per sq. ft. exclusive of curb. Either timber or concrete curb may be used, although concrete is preferable. This type can be recommended for way stations where not more than ten trains per day stop and at suburban stations where a comparatively small amount of baggage is handled.

2nd. Cement platforms 5 to 6 in. thick on cinder filling 6 in. or more in depth. Such platforms cost 13 cts. per sq. ft. To make these safe they should be finished with a wooden float and not troweled. Such platforms will not become slippery even when wet. The greater danger will be experienced when the platform is covered with a light snowfall or heavy frost, but these conditions will make any platform more or less slippery. Concrete curbs should be provided adjacent to the tracks and driveways but they are not necessary elsewhere. Such platforms will serve for all classes of stations.

3rd. Vitrified brick on a concrete base. This type of platform requires a curb and will cost about 16 cts. per sq. ft. It can be recommended only at very busy stations where a great amount of trucking is going on.

None of these types should be used, except on thoroughly settled foundations if it can be avoided. On new embankments some temporary construction should be used if possible. If absolutely necessary to have some better sort of platform the first type is preferable, on account of the fact that the brick may be removed and uneven places leveled up. All these classes

require the same drainage provisions. For large terminals concrete platforms covered with asphalt are used. The cost of the concrete, of course, varies with the depth. The asphalt coating applied about 1½ in. thick will cost 20-25 cts. per sq. ft. It provides a good wearing surface but should not be subjected to any more severe trucking than can be avoided. Rubber tired truck wheels should be used. It is of course possible to mix the mastic so that it will be hard enough to stand severe trucking, but if it is desired to secure a resilient surface for walking on it should be understood that the consistency most favorable for this purpose will not admit of very hard trucking.

Freight platforms can be built most advantageously of concrete. They may be elevated to any height desired. The side supports should be carried down below the level of the ground and safe foundations provided. The interior space should be filled with earth or gravel thoroughly compacted. Most roads, however, still use timber construction; it is cheaper for elevated platforms, especially, and can be renewed from time to time at less expense where second hand bridge timber is available for the purpose. Elevated concrete platforms cost from $.80 to $1.00 per sq. ft.

For miscellaneous platforms for use in coach cleaning yards, etc., where permanent construction is desired concrete is best. These platforms are constructed the same as sidewalks.

GEO. W. HAND,
H. A. HORNING,
G. H. JENNINGS,
PETER HOFECKER,
W. F. STROUSE,
E. M. DOLAN,
D. G. MUSSER,
P. E. SCHNEIDER,
Committee.

APPENDIX.

EXTRACTS FROM LETTERS RECEIVED.

The following are extracts from letters received from members in response to circular letter sent out by the committee:

F. Ingalls, supervisor of bridges and buildings, N. P. Ry.:—We have no buildings, and only one platform, on my division built of concrete. This platform was built some 12 years ago at the Bismarck, N. D., passenger station. It is 16 ft. wide along the track and 700 feet long, and consists of blocks two ft. square on a concrete foundation. It was built by contract at the same time the depot was constructed. We have had quite a little trouble with this platform due to failure of blocks and I am of the opinion that in the near future we will have to replace it with brick, which I think will give better satisfaction than the concrete walk is giving. We have several cinder pits built of concrete and so far they have given very good satisfaction. I am unable to give any detailed cost of same.

A. M. Van Auken, chief engineer, Memphis, Dallas & Gulf R. R.:—Reinforced concrete seems to be the coming form for factory buildings, warehouses and shops. Brick will always be used for many classes of buildings. To my mind the brick curtain wall is as good in a reinforced concrete frame building as concrete. A form of construction has been used quite largely on the Wabash and Kansas City Southern which when the cost of the building is an item seems to be in advance of anything so far developed. On the Wabash the building is of solid concrete to a height of about five ft. above the platform, above which is a wooden frame covered with cement plaster. The roof is covered with tin shingles, making a very handsome building, which costs about the same as a wooden station with shingle roof,

well painted. The Kansas City Southern building is similar, but is covered with a prepared roofing felt. It would seem that these are worthy of the study of those wishing a cheaper form of construction than solid brick. In considering the brick veneer the fact should never be overlooked that there is no possible way of securing any union between the wooden frame and brick shell and that the brick merely takes the place of wooden weatherboarding. As the brick has not the strengthening power for the frame, which weatherboarding has, it is necessary to make the frame stronger or the building will soon shed its covering of brick. Brick seems superior to concrete for station platforms. A concrete platform will develop holes under the impact of falling trunks and freight and it seems impossible to patch a hole in a concrete platform so it will remain and the hole grows steadily larger.

R. J. Bruce, superintendent of buildings, M. P. Ry.:—We have several buildings, including a roundhouse and power house built of concrete, also two tank supports, neither of which shows any economy, the latter being much more expensive than even steel supports. We have also built several smaller buildings such as oil houses, etc., generally at outlying points where bricklayers were not available. Where brick fit for building purposes can be secured for $4 per thousand for backing and from $7 to $9 per thousand for face, I see no economy in concrete buildings when built according to present methods. The durability of brick is well known while that of concrete is yet to be demonstrated. There is more chance for fraud in concrete construction than in brick. Reinforced concrete will stand more fire than ordinary concrete. In case of fire ordinary concrete walls will suffer as much as brick, but there will be some salvage from brick while concrete will cause more expense in tearing out with no salvage. Brick offers the best opportunity for remodeling. Concrete buildings for railroads will become economical and practical only after a full set of standard plans are made and with a view of economy in building forms and after the unit plan rather than monolithic is adopted. Stations could all be built on the same architectural plans, with the sizes regulated by the number of different units, and the same may be said of all buildings. I see no economy in building a frame wall, filling it with concrete and then tearing down the frame. When the body is large, such as in foundations and piers, the form charges do not enter into it so heavily.

F. C. Osborn, civil engineer, Cleveland:—In our opinion concrete and reinforced concrete can with advantage be used in all of the structures under consideration by the committee, so far as the frame work of the building is concerned, at least. We do not think it advisable to use concrete for the entire construction except perhaps in a few cases. Passenger stations, and even freight stations and warehouses as well as, in many cases, engine houses and shops, can be built at as low cost with as great durability and fire resisting qualities, with greater susceptibility of alteration and with considerably greater adaptability of architectural treatment when built of reinforced concrete frame, columns, girders, floors, roofs, etc., with brick walls, pilasters and decorative treatment.

Such small buildings as interlocking towers, light houses, tool houses, etc., can be more advantageously built with reinforced concrete frames and walls constructed of Portland cement plaster on some form of metal reinforcement. Brick is obviously unsuited to such work in most cases and concrete, except for the frame, is unnecessary.

F. E. Schall, bridge engineer, Lehigh Valley R. R.:—In my opinion the preference should be given in the following order:

Brick.

Brick alone or in combination with plain stone trimming such as lintels, sills, copings, etc., is particularly susceptible for a plain, durable and dignified treatment. In combination with cut stone or terra cotta, mouldings and ornamentation, brick is particularly good and susceptible of any desired artis-

tic treatment, especially if good judgment is exercised in the selection of the various grades, colors and shapes of brick now on the market. As to durability, maintenance and freedom from serious discoloration by the elements, brick should rank as No. 1.

Hollow Tile With Stucco Finish.

Hollow tile as now manufactured for the building trades is made in an almost unlimited number of forms for walls, partitions, sills, window jambs, window lintels, etc., and in combination with concrete and reinforcement it should rank as the very highest where a moderate sized building is contemplated, with the required features of moderate cost, fire retarding qualities, maintenance, and a reasonable amount of artistic treatment. Also in combination with brick, stone or terra cotta, some of the most artistic houses, stations, etc., in the country have been built. However, tile is particularly liable to discoloration from the elements or various other causes such as efflorescence, unequal grades of cement or aggregates used in the stucco, and it is almost impossible to remedy this except by the application of some of the various paints now made for this purpose. As this is expensive and also destroys the texture of the original soft effect of the stucco finish in a short time it invariably leaves a very unsightly looking structure. At the same time this is rather an expensive proposition, for maintenance after the original outlay, especially if the appearance of the structure is to be considered.

Concrete.

Concrete is so well known that there is little to say except that it must be confined to straight lines as far as possible in building work if a reasonable expenditure is contemplated. All attempts at ornamental treatments with concrete itself are more or less expensive according to the design, especially if tooled, washed, or bush hammered. The same objections to discoloration apply as for stucco work. Where no ornamentation is desired, but a plain neat fireproof building is required for a warehouse, tool house, signal tower, freight house, etc., it is particularly desirable from a maintenance standpoint, if the susceptibility to discoloration is not to be considered.

W. F. Strouse, assistant engineer, B. & O. R. R.:—The class of material used in railway structures should always depend upon the purpose for which it is to be used, whether temporary or permanent. If the work is to be of a temporary nature concrete should not be used under any circumstances and brick only should be used to meet city ordinances bearing on fire restrictions or insurance requirements. In razing concrete structures practically no salvage can be counted upon, while brick structures will net 30 per cent or more of the original value of the material. Permanent railroad structures should generally be built larger than the business at the time would seem to warrant, as it frequently outgrows the structure long before renewal is necessary. This is especially true in engine houses which cannot well have the spans increased to meet the increased length of locomotives. The same is true in a less degree in both freight and passenger stations, which are seldom designed to provide for future extensions.

While there is a steady growth in the use of concrete for railroad structures, I feel it will never replace brick as a general building material, but that we will find a combination of the two preferable. The use of concrete in foundations will undoubtedly increase, but more satisfactory results will be obtained by the use of brick for all exposed walls. The use of concrete floors in certain kinds of buildings, particularly where the service is severe, has gained considerable headway; but creosote blocks are likely to replace concrete for this purpose.

In the construction of roundhouses concrete is used very extensively in the foundations, pipe ducts and fire and drop pits; but outside of some re-

Lehigh Valley R.R. Passenger Station, Cortland, N.Y.

- Construction,
  - Foundations, Concrete.
  - Side walls, Hollow tile, cement stucco finish.
  - Partitions, Hollow tile.
  - Floors,
    - First floor, concrete and Terrazo.
    - Second floor, wood.
  - Roof, Timber construction.
  - Roofing, Tile.
  - Interior Finish
    - Walls and ceilings, plastered on plaster board.
    - Trim, 1st floor, chestnut.
    - " 2nd " N.C. pine.
- Size,
  - First Floor, 25'x 109'
  - Second " 28'x 31'
- No. of Stories, One with small 2nd floor over tkt. ofs.
- Cubic contents, 77,000 ft.
- Platforms, Concrete,
  - Area, 7350 sq.ft.
  - Cost, @ 17¢ = $830.
- Fire Protection,
  - Stand Pipes, 1st to 2nd floor.
  - Supply, City pressure.
- Fire Resisting Qualities.
  - Fair.
  - Probable loss by Fire,
    - Practically all except foundations and possibly part of walls.
- Cost,
  - Total, $19,000, exclusive of platforms.
  - Per cu.ft., Abt. 24¢, inc. canopy at end.
  - Per sq.ft., $6.50 exclusive of platfms.

- Lehigh Valley Railroad. Passenger and Freight Station. MILAN, PA.
  - Station Portion,
    - Construction
      - Foundations, Concrete
      - Side Walls, Hollow Tile.
      - Partitions " "
      - Floors, Concrete.
      - Roof, Timber.
      - Roofing, Roofing Paper.
    - Size, 19.5'x 28'
    - No. of stories, 1.
    - Cubic contents, 9800 ft.
  - Freight House,
    - Construction
      - Foundations, Concrete.
      - Side Walls,
        - Hollow tile filled to a ht. of 6' above floor with Concrete.
        - Cement plastered ea. side.
      - Floor, Concrete.
      - Roof, Timber.
      - Roofing, 2 ply Paper.
    - Size, 19.5 x 24'
    - No. of stories, 1.
    - Cubic contents, 8400 ft.
  - Platforms,
    - Freight House
      - High platform, concrete reinforced with ½" ϕ rods.
    - Station, Concrete.
  - Fire Protection
    - Station, Standpipe.
    - Freight House, Hydrant.
  - Fire Resisting qualities.
    - Fair.
    - Probable Loss by fire,
      - Roof, Windows and doors.
  - Cost,
    - Total, $ 3,600.
    - Per cu. ft., about 20¢.
    - Per sq. ft., - $3.50 -

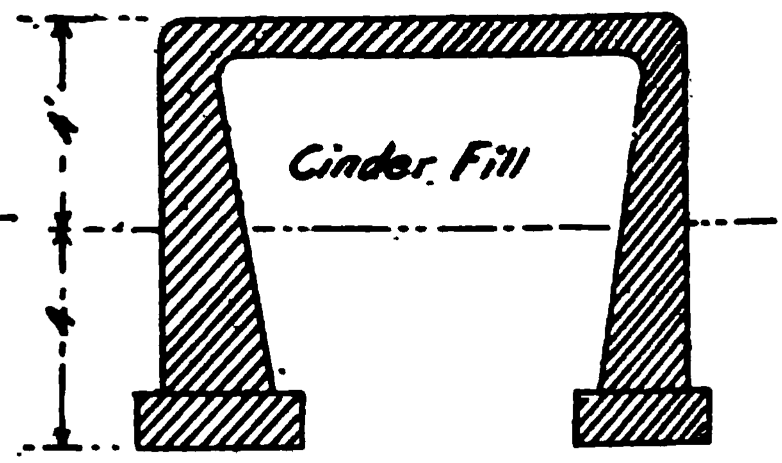
- Lehigh Valley Railroad, Freight House, So. Bethlehem, Pa.
  - Office portion,
    - Construction,
      - Cellar Walls, Concrete.
      - Foundations, "
      - Side walls, Hollow tile, cement plastered.
      - Floors, wood.
      - Roof Trusses, Timber.
      - Partitions, "
      - Roofing, Slag.
      - Inside Finish, Plastered walls, wood trim.
    - Size, 45' x 54'
    - No. Stories, 2
    - Cub. Contents, 80,000 ft.
  - Freight House,
    - Construction,
      - Foundations, Concrete.
      - Outside Walls, "
      - Fire Walls, "
      - Floors, "
      - Roof, Timber.
      - Roofing, Slag.
      - Canopy overhangs, Timber.
    - Size, 69' x 254' (Irregular in shape.
    - No. Stories, 1.
    - Cub. Contents, 450,000 cu. ft.
  - High Platform,
    - Construction,
      - Ret. Walls, Concrete.
      - Filling, Cellar dirt & cinders.
      - Floor, Concrete.
      - Reinforcement, ½" ϕ rods.
  - Fire Protection,
    - Fire Walls, 3 of concrete with automatic doors
    - Hydrants, Inside freight rooms.
    - Stand Pipes, In office, cellar to 2nd floor.
    - Supply, City Pressure.
  - Cost,
    - Total, $35,000.
    - Per cu. ft., 6 7/10 ¢.
    - Approx. Sub-divid.
      - Office, per cu. ft. 12¢.
      - Frt. House, " " " 5 7/10 ¢
      - Platform, per sq. ft. 85¢
  - Fire Resisting Qualities.
    - Office,
      - Fair, from outside fire.
      - Probable loss, all above foundations.
    - Freight House.
      - Very good.
      - Probable loss, Roof and Windows.

Lehigh Valley Railroad. Reinforced Concrete Roundhouse at Coxton, Pa.

- Number of stalls, = 16
  - Size of each stall
    - Inside circle, 13.29'
    - Outside " 23.75'
    - Length, . . . 90.
    - Angle, . . . 6°-40'
  - Area, 26,640 sq. ft.
  - Cubic contents, 626,040 ft.
- Construction
  - Foundations, concrete, 1:3:5 stone
  - Columns, " 1:2:4 "
  - Roof beams, " " " "
  - Roof " " " "
  - Side curtain walls, Hollow tile plastered.
  - Floor, Concrete.
  - Windows, wood.
  - Doors, rolling wood shutters.
  - Jacks, Concrete
  - Reinforcement
    - Columns and beams, ϕ rods.
    - Roof, ϕ rods and exp. metal.
    - Side walls, none.
    - Jack and smoke curtains, ϕ rods and exp. metal.
    - Ventilators, " " "
- Fire Protection, - None provided
- Fire resisting Qualities.
  - Fire-proof
  - Probable loss by fire
    - Doors and Windows
      - About 8% of total cost
- Cost.
  - Total, \$50,000.
  - Per stall, 3,125.
  - Cu. ft., about 8¢
  - Sq. ft., . . . \$1.87
    - Exclusive of heating, Lighting and Piping

Platforms:-

High Frt. Platforms;-



Cost reinforced about 75¢ to $1.00 per sq. ft.

Low Station Platforms;-

Cost about 15¢ to 19¢ per sq. ft.

Transfer Platforms:-

Lehigh Valley Railroad. Manchester. (Proposed)

- Construction,
  - Substructure, concrete reinforced.
  - Superstructure, Steel frame, wood roof. Prepared roofing.
  - Buildings, Hollow tile, plastered.
- No. of platforms, three.
- Size of " 25' x 800'
- Area of 3 " 60,000 sq. ft.
- Cost,
  - From contractors est., about, $73,000, exclusive of buildings.
- Cost, per sq. ft., about $1.21
- Total cost, Including office, bunk room, coal room, Supply rooms, cellar, heating, lighting, scales, water supply, etc., about $ 90,000.
- Cost per sq. ft., about $1.50.

inforced concrete lintels the sills, exterior walls and fire walls are generally built of brick. Oil houses and terminal storehouses should be constructed of a combination of brick and reinforced concrete, both from a standpoint of durability and for fire resisting qualities.

Cinder pits can be built to very good advantage of concrete except that those portions which come in contact with hot cinders should be lined with vitrified brick, as the sudden chilling, when wetting down the cinders, is liable to cause considerable injury to the concrete if not protected by brick-work.

Brick platforms with concrete curbs are now used very extensively at smaller stations and at points where changes are likely to be made, as alterations can be made in brick platforms with comparatively little loss of material. Concrete platforms are preferable in the larger stations where large trucking is done and where they are covered. Platforms of either brick or concrete are dangerous when covered with snow or ice, but brick platforms are rougher than concrete and consequently preferable where exposed. In the ordinary platform there is little difference in cost between brick and concrete, for what is saved in the brick work is lost in the cost of concrete curbs which must be used, while concrete platforms, in many instances, can be constructed without the use of curbs. This is especially true in coach cleaning yards where a platform, say five feet in width, can be constructed between the tracks on top of the cinder ballast, bringing the top of the platform to the same elevation as the top of the rail, the cinders having first been thoroughly compacted to the top of the tie.

In regard to the relative cost of brick and concrete construction it is found that the cost of forms for concrete in most instances, offsets the saving in cost of the material, particularly when the walls are thin and architectural treatment is considered. If properly constructed, one material should be as safe as the other. While we have no definite information, a good quality brick structure should outlast a similar structure of concrete.

The fire resisting qualities of brick are greater than those of concrete, on account of the deterioration of most kinds of stones when subjected to intense heat. The Baltimore fire, however, demonstrated the fact that good reinforced concrete will withstand severe heat with little damage. Concrete is not so susceptible of alteration as brick. New concrete does not bond well with old and it is extremely difficult to effect harmony in color. Concrete, if damaged by having the edges or corners knocked off, is very difficult to repair, while brick work can very readily be repaired by replacing the damaged brick with other brick of the same character and quality. Brick work responds more readily to artistic design in architectural treatment than concrete, except in the plainer orders.

R. P. Mills, supervisor of buildings, and C. C. Warne, assistant division engineer, N. Y. C. & H. R. R. R.:—The use of concrete for passenger stations and combination passenger and freight stations on the territory coming under our jurisdiction has been mainly restricted to foundations, or that portion of the buildings below the floor sills. In a few structures, the side and end walls have been built of concrete from the bottom of the foundation up to the under side of the windows. We use 1:3:6 crushed stone concrete which can be placed for about $6 per cu. yd., the cost of the stone being 75 cts. per yard at the crusher. Our price per cubic yard includes the handling of the material, building of the forms, mixing of the concrete, and the placing and removing of the forms. The concrete is usually mixed by hand. To obtain a good surface, it is usually spaded alongside the front form, and when the forms have been removed all rough spots are reduced by floating. For this purpose we use a cement brick made on the job. We can also obtain a rustic effect by using pebbles in the concrete. These pebbles are used in the face of the concrete only. In placing them a steel plate is used with ribs attached, allowing a space of about 1 in. between the form and the plate. In this space the pebbles and concrete are placed. The remaining concrete is placed against the back of the plate, which is raised as the work proceeds. We take the form down when the concrete is a little green, and remove the concrete from between the pebbles with wire brushes, exposing them. The additional expense for this we find to be about $2 per cubic yard. We find

concrete for this purpose very satisfactory and would always use it in preference to brick. As we have never used concrete for the body walls of a building, with the exception noted, we can give no comparative figures covering the cost of construction and maintenance. From our observation of the wearing qualities of concrete and brick, we believe they are about equal, so that from the standpoint of the cost of renewals, we believe the item of maintenance can be eliminated. If the surface is to be painted, which is sometimes done, it would seem to us that the paint would last longer on a concrete surface and that a smaller quantity will be required per sq. yd. on account of less absorption.

We would consider concrete safer than brick for foundations because a mass of concrete is stronger than a mass of brick work, and is less liable to crack on account of uneven settlement. Where soft soil is encountered, it is a simple matter to re-inforce the concrete with old rails or rods, making a very strong type of construction, which will distribute the pressure over a large area. With brick work, this form of construction cannot be obtained. As far as the walls of the building are concerned, providing that the foundations are stable, it would seem that the relative difference in the strength of the two materials would be of no consequence. The materials are about equal in durability.

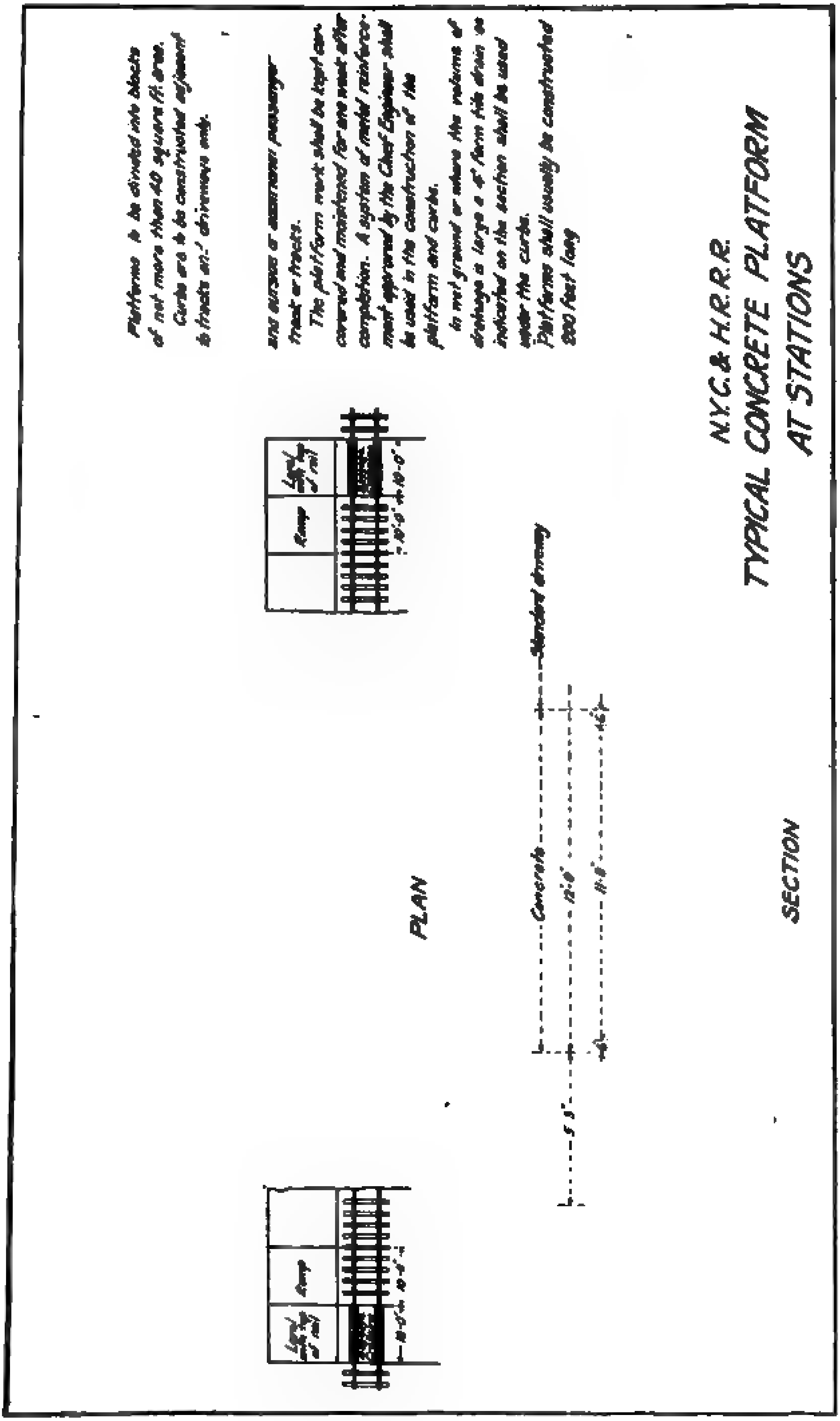
Brick work has always been known as a good material to resist the action of fire, and it is extensively used in fire-proofing buildings. It seems to us that brick work would offer more resistance to fire than crushed stone or gravel concrete. We have seen some cases, however, where concrete has been subjected to very severe conditions, and one especially in the burning of a coaling station. The foundations of this building were covered with burning coal for a number of days, and when uncovered, the concrete was found to be in first-class condition. However, if we expected concrete to be exposed to the action of fire, we would recommend the use of cinders in place of natural stone or gravel.

We have found it much easier to cut holes in brick than in concrete walls, also in tearing down sections of walls for placing windows, there is a better opportunity for obtaining a bond between the old and new work. The great difficulty in joining a mass of fresh concrete with old concrete is that owing to the shrinkage of the new concrete, a crack will likely occur at the junction.

Both concrete and brick can be used to obtain fine architectural effects, only on somewhat different orders. With concrete, large masses can be formed ornamented with carvings or figures. Massive lintels and sills give a very good effect. In fact concrete is subject to about the same architectural treatment as stone masonry. With brick work, the architectural features are restricted to arches, corbeled brick, geometric figures, and differently colored brick work, proper combinations of which are very pleasing. In comparing the two materials a great deal rests upon the individual's taste.

What we have said in regard to passenger stations will apply generally to freight stations and warehouses on our territory. These stations have been built entirely of brick, and we consider this a very satisfactory material.

The engine houses which we have constructed have been built of brick, although we think that concrete could be used to good advantage for this type of structure. We think that concrete might be a more durable material. We found in tearing down the walls in our old engine houses that the gases seem to have affected the brick work, making it rotten. We do not think gases would have the same effect upon concrete. We believe concrete can be used very well for roofs of engine houses and shops; for these re-inforced concrete would give a very durable roof. In so far as brick work has never been used for this purpose, the use of re-inforced concrete would hardly come under this discussion. In the consideration of a roof of this character, there is one thing that should not be overlooked, and that is the condensation of vapors and gases, causing drippings which are annoying to the workmen and hard on engines and tools.


Platforms to be divided into blocks of not more than 40 square ft. area.
Curbs are to be constructed adjacent to tracks and driveways only.
and outside or additional passenger track or tracks.
The platform work shall be kept covered and moistened for one week after completion. A system of metal reinforcement approved by the Chief Engineer shall be used in the construction of the platform and curbs.
In wet ground or where the volume of drainage is large a 4" farm tile drain as indicated on the section shall be used under the curbs.
Platforms shall usually be constructed 200 feet long
Ramp
PLAN
Concrete
Standard driveway
SECTION
N.Y.C. & H.R.R.R.
TYPICAL CONCRETE PLATFORM
AT STATIONS

We believe a stronger cinder pit can be built of concrete, especially on soft ground, from the fact that concrete can be re-inforced with old rails. Where the foundation is good, one material is about as good as the other. We find that with brick pits, it is almost impossible to keep the mortar between the bricks, as it is jarred out by the vibrations of the moving engines. We experience no trouble of this kind with concrete. As concrete has been used only in the last ten years, we have no case where we have been able to compare the life of a concrete ash pit with a brick pit; we think that concrete will last just as long. If concrete is made with cinders instead of natural stone or gravel, it will resist fire as well as and probably better than brick work.

We have not constructed any platforms or walks out of brick within the last ten years, having used concrete exclusively for this purpose. We can build a concrete platform or walk for about 13 cts. per sq. ft. When well laid, we find the cost of maintenance to be practically nothing. A concrete platform is much easier to keep clean than brick. Also if brick work is not given a great deal of attention, weeds and grass will grow between the bricks. When the surface of the concrete is properly roughed in finishing it gives a safe surface. Unless the brick is laid on a concrete sub-base, the bricks are liable to settle unevenly, making the surface somewhat rough, which might cause passengers to stumble by striking their toes against the raised brick. We believe that concrete platforms will last longer than brick.

There is one thing to be taken into consideration in the use of platforms which is not covered by the different headings already discussed, and that is the resistance to traction in the hauling of baggage trucks over the platforms. We believe the concrete surface offers much less resistance to the baggage truck than brick, and for this reason heavier loads can be drawn. When trucks are drawn over brick work, they are jarred to a considerable extent, which frequently causes baggage to fall off the trucks. A truck is more difficult to control on a brick surface than on one of concrete.

A. Montzheimer, chief engineer, and Geo. H. Jennings, superintendent bridges and buildings, Elgin, Joliet & Eastern Ry.:—We have no brick or concrete passenger stations as the E. J. & E. is strictly a freight road. Our stations are no more than offices and freight houses. We have a concrete block office building used by one agent at Buffington, Indiana, the foundations being monolithic and the walls above the foundations being hollow concrete blocks. Previous to the adoption of concrete for general building construction we used brick, the average thickness of walls being 13 in., composed of a facing of Hobart, Ind., pressed brick and backed with Chicago common brick. A wall of this description will lay up about 18 bricks per superficial foot, and will cost on an average $17 per M., laid in the wall. This makes the cost of brick walls of this description 30.6 cts. per superficial ft. The concrete blocks are 8 in. thick and arranged to lay in stacks so as to provide ample ventilation at all times. They cost 30 cts. per superficial foot laid in the wall, including the cost of making the blocks and all materials. The only objection that has been raised against the use of concrete walls for buildings is the dampness on the inside of the walls. Whenever this dampness appears, it is due to improper construction of the blocks, or to insufficient ventilation. Care should be taken to procure blocks that provide for at least a 1 in. air space or greater at all points in the wall.

We had occasion to build a fireproof vault of these hollow concrete blocks and after it was completed and plastered it seemed impossible to get it dried out. The roof was of monolithic reinforced concrete, covered with prepared roofing. This roof dripped continually and the plaster was not hard at the end of three weeks. We installed two cast iron gratings or ventilators on opposite sides of the vault, against the soffit of the cornice, and the vault became dry in two days. It has given no trouble since. This simply illustrates that concrete is cheaper, and just as desirable as brick, for building purposes, provided the walls and the building are properly ventilated.

The cost of concrete block construction for the vault mentioned above was as follows:

12 cu. yds. limestone screenings at .$60,	$ 7.20
12 cu. yds. torpedo sand at $.50,	6.00
75 sacks cement at $.3625	27.19
Labor making and handling blocks to job	68.00
Cost of laying blocks in wall	59.00
	$167.39

Above cost includes all scaffolding necessary, but does not cover any cost for rental of machinery for making the blocks, as we borrowed the machinery, no charge being made for it. In case rental or royalties have to be paid, this price should be increased accordingly.

There were 584 superficial feet in the walls of this building. This represents a cost of 28.6 cts. per superficial foot. The average size of these blocks was 10in.x23¾in.x7¾in. Allowing for ¼ in. joints, each block would lay 10¼in.x24in. face, the thickness of wall being 7¾ in. In using this style of block the inside of the walls must be furred before the lath and plaster are put on.

Below is given a statement of the cost of manufacturing and laying blocks for a pump house and gas engine building at the Illinois Steel Company's plant. This cost is divided into four items, the construction of the plant, the cost of manufacturing the blocks, the cost of erection of the pumping house and the cost of erection of the gas engine electric station.

To the construction of the plant was charged the cost of clearing the ground, erection of the machinery and storage bins and the purchase price of cars and pallets for handling the blocks. The block machine and the mixer were not purchased but were rented at a rate of $60 per month. This rental is charged to the manufacturing cost. The cost of manufacturing blocks is divided into the cost of material and cost of labor.

To the erection of the buildings was charged the cost of handling the blocks from the stock pile to the buildings as well as the cost of laying them. In comparing the cost of these blocks with that of common brick, it was considered that one standard block was equivalent to 16½ common brick, as each block lays up ¾ of a cubic foot when laying a 12 in. wall.

The price given in the accompanying table is a little high on account of having to install such an elaborate plant to carry on the work properly. These blocks are 9in.x24in. and the thickness of the wall 12 in. This style of block provides for an air space throughout the entire length and height of the wall, the smallest air space through the center of wall being 1 in. wide.

COST OF CONCRETE BLOCKS FOR BUILDING PURPOSES.

Data Secured in the Construction of a Pump House and Gas Engine Building at the Illinois Steel Company's Plant.

(The figures in the right hand column represent cost per block.)

Construction of Plant.	Amount.		
Freight on machinery	$ 39.90		
Transfer cars,	732.28		
Erection of machinery,	427.25		
Electric wiring,	16.08		
Steam drying room,	378.07		
Storage bins for cement and slag,	165.85		
Stock of wood pallets,	502.53		
Steam and water piping,	102.41		
Clearing ground,	144.86		
Miscellaneous construction charges,	85.88		
Tracks,	143.11		
Total construction charge,		$2,738.22	.0678

Manufacturing Material.

Rental of machinery,	$ 240.00	
Cement, 971 bbls. @ 1.246,	1,210.00	
Limestone screenings, 577 yds. @ .198,	114.28	
Sand, 130 yds. @ .530,	68.87	
Steam,		
Water,		
Electric light and power,	70.37	
Forms for special shapes,	13.65	
Repairs,	25.97	
Miscellaneous supplies,	15.14	
Scrap for reinforcement,	43.35	
Total,	$1,801.63	

Labor.

Superintendence,	$ 402.50		
Labor making blocks,	1,055.33		
Handling from machine to storage pile,	254.25		
Miscellaneous producing labor,	45.15		
Repairs,	162.14		
Total,	$1,919.37		
Total manufacturing cost,		$3,721.00	.0921

ERECTION OF CONCRETE BLOCK BUILDING WALLS.

Aqueduct Intake Pump House.

Loading blocks into cars,	$ 41.48		
Handling from cars to building,	58.45		
Staging and platforms,	151.49		
Labor laying blocks,	553.05		
Miscellaneous supplies,	44.92		
Switching charges on blocks,	6.00	$ 855.39	.1375

Electric Station.

Loading blocks into cars,	$ 180.66		
Handling from cars to building,	174.57		
Staging and platforms,	1,103.70		
Labor laying blocks,	1,972.86		
Miscellaneous supplies,	239.69		
Switching charges on blocks,	63.00	3,734.48	.1434
Total cost of laying blocks,		4,589.87	.1422
Number of blocks made,	40,409		
Number laid in pump house,	6,220		
Number laid in gas engine house,	26,049		

The foundations for the buildings on the E. J. & E. are all of concrete, and when put in place with the balance of the buildings not requiring a special movement of a bridge and building gang, cost us $5 per cubic yard, including cost of material, forms complete and all labor. We have two ¼ yard Smith mixers, mounted on wagon trucks with a steam boiler and engine that we use for this purpose. These mixers are light and can be unloaded and loaded by hand on a flat car. They can also be moved about on the job to convenient points, avoiding much wheeling. An ordinary gang of eight men and foreman can mix and place 50 to 60 cu. yds. of concrete per day of ten hours with one of these outfits, the output depending on the distance that the concrete has to be wheeled.

We have made experiments with these mixers and have found that we can save $1 per cubic yard on each yard mixed compared with mixing by hand. Of course the job must be large enough to warrant use of mixer. We use mixers on all jobs of over 25 cubic yards, and obtain better concrete than can be mixed by hand at a greatly reduced price.

Our standard ingredients are crushed washed gravel, washed torpedo sand and Universal Portland cement; the detailed cost of one yard of concrete is as follows:

1 cu. yd. crushed washed gravel,	$ .40
½ cu. yd. washed sand,	.25
1 bbl. Universal Portland cement,	1.50
Labor per cu. yd. mixing and placing,	.44
Freight and form work complete,	2.41
	$5.00

In reference to maintenance, we have found that buildings made of concrete can be maintained at a less cost than brick buildings laid with lime mortar. We are obliged from time to time to point up our brick buildings; also to remove and relay portions of walls when frost has affected brick. We have experienced no trouble with concrete due to the action of frost.

We consider concrete safer for any description of building work than brick, provided the same is properly designed and executed. Monolithic concrete cannot be handled as safely as brick work in freezing weather. We have, however, placed reinforced concrete in very cold weather that turned out to be perfect. It is very expensive to handle concrete in freezing weather, and we do not recommend it, as frozen concrete will fail sooner than from any other cause.

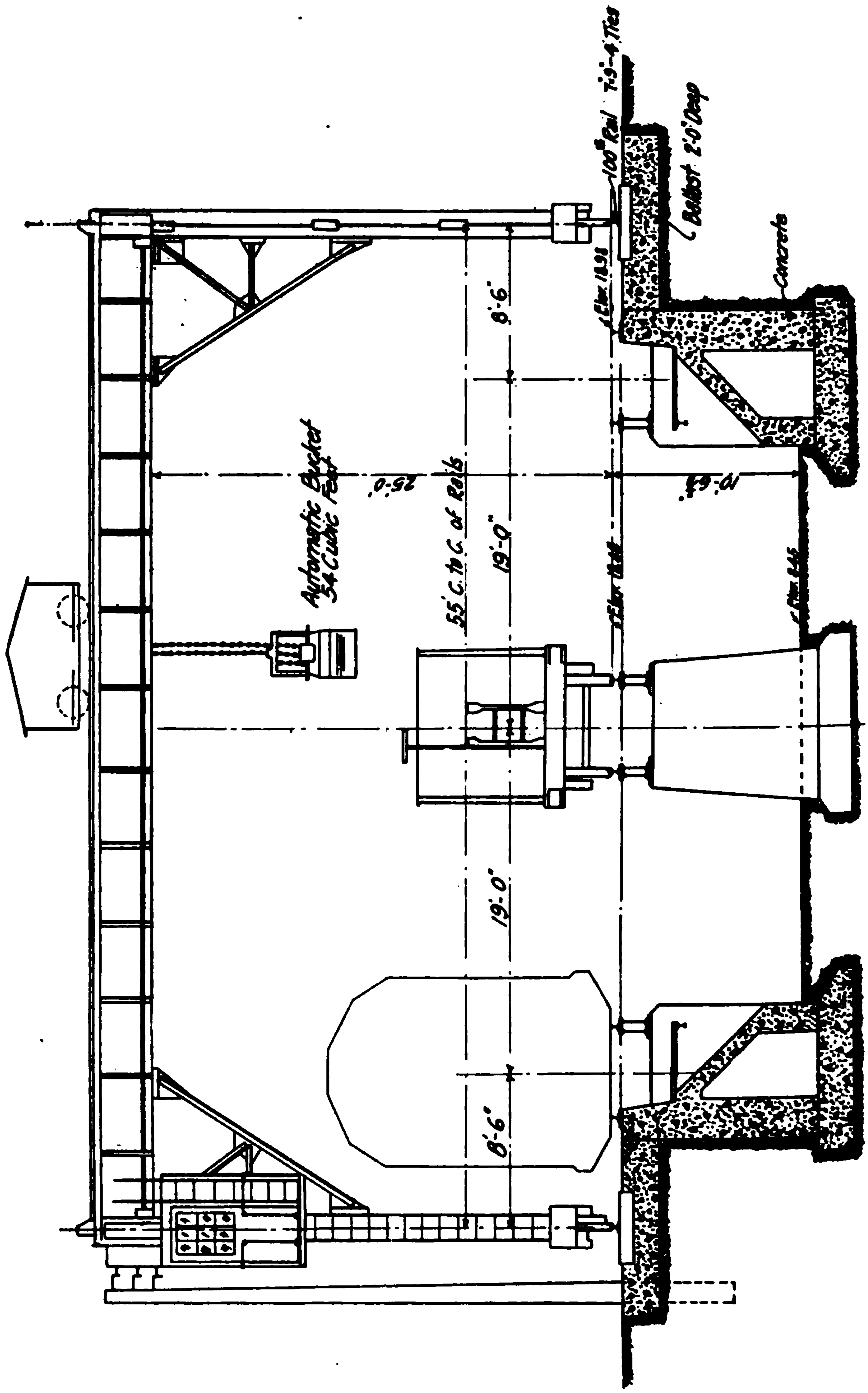
Where concrete blocks are made and properly cured, they can no doubt be laid in cold weather as safely as brick, as brick work requires more joints per superficial foot of wall than concrete blocks.

By using reinforced concrete in foundations the loads can be distributed over greater areas than is possible with any other type of construction. This represents great economy where heavy loads are to be supported on insecure footing.

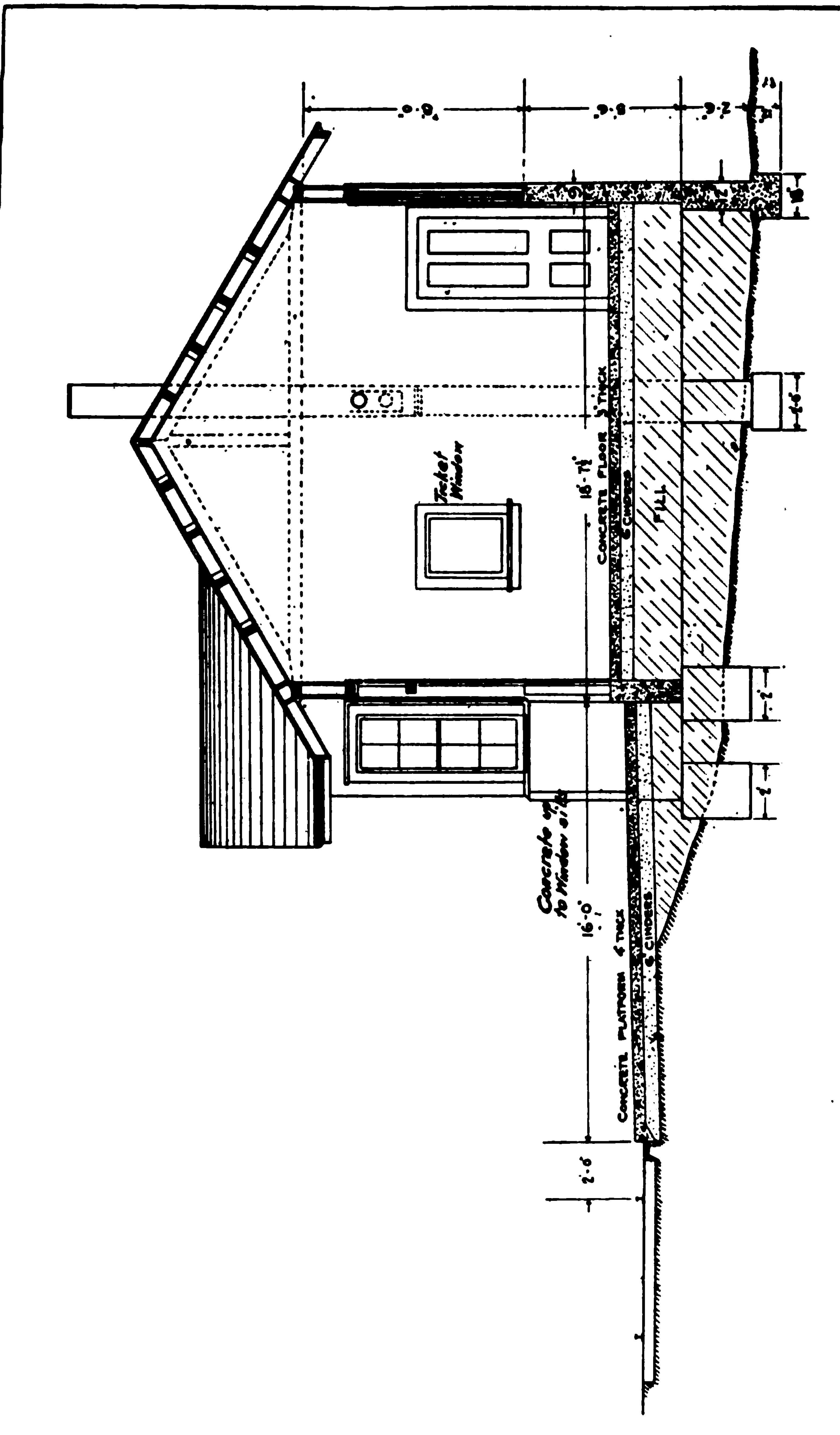
We have been using concrete for building purposes for the past five years. and have had no failures; neither have we observed any indication of deterioration.

Our experience is that brick will resist fire better than concrete. Excessive heat will cause concrete to crack and crumble. We base this statement on our experiences with concrete cinder pits. We had an explosion and fire in our storehouse at Gary some years ago, which might be of some interest. This building is constructed of brick side walls, steel roof trusses and purlins, with a 4 in. monolithic reinforced concrete roof, covered with tar and gravel. Shortly after this building was completed, spontaneous combustion caused a fire in the fusee storage; this spread to the torpedoes, a large stock of which was stored adjacent to the fusees, causing a tremendous explosion that filled the entire building with fire. Several panels of the brick walls were blown out and the entire roof raised from the purlins at least six inches, but it settled back into place without cracking the concrete at any point. Short pieces of 2x4 timbers, rolls of paper, bolts, etc., were blown between the purlins and roof while the roof was in the air, and some of this material can be seen at this time, located as described above. The fire did not damage the roof except directly over the point where the explosion occurred, where about 1 in. of the under portion of the roof scaled off about two or three ft. square.

It is easier and cheaper to alter brick work in any class of building than concrete. Brick walls can be taken down and the same bricks used in rebuilding, whereas a concrete wall is a total loss if taken down, and is much more difficult to handle. It is also very difficult to refinish the wall where an opening is made in concrete work.



Cinder Pit with Gantry Crane at Gary, Ind., C. L. S. & E. Ry.



Combination Depot at Naples, Ill., Wabash R. R.

We believe that with the proper treatment of concrete the same results can be obtained as with granite, marble, Bedford stone, brick or any other building material.

With reference to interior work, the offices of the Universal Portland Cement Company at Buffington, Ind., are finished inside, including the stairs, hand railings, floors and ceilings, in concrete. The ceilings are all made as follows: Beams were cast about 4 ft. center to center of reinforced concrete, being exposed on three sides. The faces of these beams were colored to match the balance of the room. On these beams concrete slabs were laid with the exposed side polished, the slabs being made of various kinds of stone screenings to give different colors. This makes a beautiful ceiling, resembling polished marble. The stairs, hand railings, etc., were cast and treated like the slabs.

We have adopted reinforced concrete as a standard for all our roundhouses. At the present time we have three of these houses in service, and one under construction.

Our roundhouse at Waukegan, Ill., is a 15 stall monolithic reinforced concrete house, except the roof, which is composed of reinforced concrete slabs. This building is composed of concrete throughout, including the floors, pits, foundations and walls.

A reinforced concrete extension in the rear of the house is used as a machine shop which should be treated as one additional stall in arriving at the price per stall. The entire building, except the slabs for the roof, was poured in place on the job, including all beams and columns. The slabs were made in Chicago, shipped to Waukegan on cars, and placed with a derrick. A five ply tar and gravel roof was then put on. A saving of $1,000 was made on this building by using unit roof slabs.

At East Joliet we have in service a 17 stall reinforced concrete roundhouse, the construction of which is the same as the 15 stall house at Waukegan, except that the entire building is monolithic, being cast on the job complete.

These buildings are both heated with hot air delivered into the engine pits by means of underground conduits. Great care should be taken in selecting the heating coils and fan, as we have found that a plant that will heat a brick house with a timber roof is entirely too small for the same sized building, if made of concrete. The concrete house requires more ventilation than a brick house to avoid condensation on the inside of the walls and the under side of the roof in cold weather.

The slab construction is considerably cheaper than the monolithic construction in these roofs, but we do not feel that it is as good, although we have had no trouble with either of them. These buildings were completed in the spring of 1911.

At Gary, Indiana, we have a 20 stall brick roundhouse with concrete foundations, brick side walls and timber posts and with a slow burning roof construction, covered with prepared roofing. This building was completed in 1908. The dimensions of this house are the same as the reinforced concrete houses, each stall measuring 28 ft. 3 in. across the back, 15 ft. 6 in. across the front, and 85 ft. clear length inside. These buildings are all comparatively new, so we can give no comparison of costs of maintenance of the two types of construction.

We consider concrete a safer construction for engine houses than brick, as the timber or steel usually used in roofs of brick houses is liable to fail because of the steel rusting away or the timber construction burning.

We have no concrete shops completed to date. We have a locomotive shop under construction 150ft.x600ft., steel frame, concrete block walls and steel sash, but are not in a position to make a report on this at present.

A. O. Cunningham, chief engineer, Wabash R. R.:—The following gives a partial list of the material and shows the cost of a combination depot. 18ft.x 42ft. at Naples, Ill.:

MATERIAL.

CONCRETE.

Walls, piers, chimney and chimney slab, 35 cu. yds., requiring 158 sacks Portland cement, 14 cu. yds. sand and 28 cu. yds. of gravel.

Floors, 3 in. thick, 405.5 sq. ft., requiring 16 sacks Portland cement, 2 cu. yds. sand and 4 cu. yds. gravel.

Floor, 4 in. thick, 325.4 sq. ft., requiring 17 sacks Portland cement, 2 cu. yds. sand and 4 cu. yds. gravel.

PLASTERING.

Outside, 1½ in. thick, 97.5 sq. yds., requiring 43 sacks Portland cement, 4 cu. yds. sand, 1½ bbls. lime and 5 lbs. fiber.

Inside wall, 1 in. thick, walls, chimney and ceiling, 178.4 sq. yds., requiring 51 sacks Portland cement, 5 cu. yds. sand, 2 bbls. lime and 7 lbs. fiber.

Total material required for concrete wall, floors and plastering:

285 sacks Portland cement @ 42c.,	$ 119.70
27 cu. yds. sand @ 30c.,	8.10
36 cu. yds. gravel, @ 50c.,	18.00
4 bbls. lime, @ 70c.,	2.80
12 lbs. Excelsior cocoanut fiber, @ 5c.,	.60
298 sq. yds. trussit, 27 gage, @ 30c.,	89.40
8 steel corner beads, @60c.,	4.80
9 gal. Symentrix for outside plastering, @ $1.50,	13.50
	$ 256.90
Cinder fill, 221 cu. yds, @ 17c.,	37.57
Lumber, consisting of No. 1 yellow pine, 3,398 ft. B. M., @ $23	78.15
1,750 ft. sheathing, @ $26,	45.50
500 ft. ceiling for eaves, @ $28,	14.00
Mill work, consisting of windows, doors, frames, counter, record case, telegraph table, etc.,	170.29
Hardware,	46.56
13¼ squares Cortright metal shingles, @ $4.25,	56.31
24 lin. ft. valleys, @ 10c.,	2.40
47 lin. ft. ridge, @ 12½ c.,	5.88
Painting and glazing,	31.85
Total, material,	$ 745.41

LABOR.

6 cu. yds. excavation, @ 25c.,	$ 1.50
230 cu. yds. grading fill and cinders for floor, at @10c.,	23.00
35 cu. yds. concrete foundation, @ $3,	105.00
405 sq. ft. floor, 3 in. thick, @ 5c.,	20.25
325 sq. ft. floor, 4 in. thick, @ 5¼c.,	17.06
Plastering, outside and inside,	104.42
Putting on 298 sq. yds. metal lath, @ 2½c.,	7.45
Carpenter work, framing 5.65 M. ft. B. M. lumber, @ $12.50,	70.63
Metal shingles, 13¼ sq. @ $1.50,	19.88
Painting and glazing,	55.65
Contingencies,	119.75
Total labor,	$ 544.59
Total labor and material,	1,290.00

PLATFORM.

Material.

32 cu. yds. cinders, @ 17c.,	$ 5.44
965 sq. ft. concrete platform, 4 in. thick, requiring the following:	
50 sacks cement, @ 42c.,	21.00
6 cu. yds. sand, @ 30c.,	1.80
9 cu. yds. gravel @ 50c.,	4.50
	$ 32.74

Labor.

Grading,	$ 4.00
32 cu. yds. cinder foundation @ 10c.,	3.20
965 sq. ft. concrete platform @ 5½c.,	50.66
Contingencies,	9.40
	$ 67.26
Total, labor and material,	100.00

DISCUSSION.

The President:—Gentlemen, we would like to hear from the members regarding their experiences with reference to the subject in hand. The report seems to be quite complete, but there may be some points which are not brought out.

Mr. J. S. Robinson:—I think that brick is unquestionably as good as concrete in all climates and generally better for buildings, and I think also that it is far better for platforms, as well. If laid in large slabs, concrete floors become irregular, and crack, while brick can be laid economically on a sand cushion, holds its surface well, and will last a great many years. I think it is cheaper and better wearing, as a rule, than concrete and costs considerably less, when laid flat. On the way here from Chicago, I noticed a great many platforms where the brick are laid on edge. On the Northwestern system we discontinued that method some years ago and find that we can lay brick platforms, where the brick are laid flat, for seven or seven and one-half cents a square foot.

Mr. Pickering:—I would like to ask Mr. Robinson if he has any difficulty with the brick breaking under heavy trucks? Up in our country we use trucks that are frequently loaded with from one to two tons of baggage and we have a good deal of difficulty in maintaining a platform of that character, or a concrete platform that will not crack under such loads.

Mr. Robinson:—We have never had any brick break under traffic. We have had them crack by throwing heavy loads, such as freight and large pieces of baggage on them, where the metal came in contact with the platform and cracked the vitrified surface; then they deteriorate very rapidly. We lay the brick with close joints and fill the intervening spaces with sand. When a brick is broken we can remove it easily with a hook and replace it at a small cost. We use 12 in. of cinders and two in. of sand as a cushion for the foundation.

Mr. Long:—I notice in the report the illustration of the Gary, Ind., station and I want to give you our experience of the life of the concrete in those walls. Concrete, like brick, requires furring on the inside, in order to keep it from sweating. We had recommended to us a waterproofing paint which we used on the interior instead of the furring strips, as it was cheaper. Unfortunately, this waterproofing was a failure and the outside walls of this station are peeling badly, so that we contemplate removing it with wire brushes and trying to find something that will take its place and make the walls waterproof. The proper method of waterproofing concrete, in my opinion, has not been definitely settled. There are a number of products which are mixed with concrete which are claimed to give good results. We have not tried them as yet, but what we have applied to the outside of buildings have not been altogether successful.

The Secretary:—Since Mr. Long is an architect, I would like to ask how he regards concrete as compared with brick for a structure of that kind, generally speaking?

Mr. Long:—Generally speaking, if I could make it watertight, it would give much better results, in some types of architecture than brick would. It cost us no more for this building than brick would have cost. We designed it in the classical style of architecture and made of it an all-concrete building, because we got the cement at Buffington, near by. We did it principally at the suggestion of the United States Steel Co., who wanted to have an all-concrete building, made entirely of steel and Portland cement, as a show-card for their material. In designing this, we kept in mind the fact that this was taking the place of stone. If I had designed the building for a stone building, I would have used the same construction I used here, but had it been designed for a brick building, I would have built it a great deal different and used a different construction. Concrete, as a general rule,

costs more than brick, because, as the contractor said when we started building this structure, the forms he had to make—he called them the "fifty-seven varieties"—created considerable expense for that item.

Mr. J. H. Markley:—We have not, as yet, used any concrete in the construction of our passenger or freight stations, but we have two stations that cost $10,000 each, one that cost $6,000, one that cost $2,600, and one that cost $3,000, of brick veneer. We do not contemplate building anything else in the future, for stations costing about $2,000. We built the station, a cut of which is shown in the Railway Age Gazette of May 17 last, for $2,800.

To illustrate the practicability and the feasibility of this character of structure, which is better than wood, we had a joint station built on the road of practically the same size with a metal roof put on it that cost $2,500 and was not nearly as good a looking building. Another thing that ran the price up on this building was the concrete foundation. We got into a soft place and had to increase our footings considerably over what they would have been if we had got into an ordinary clay soil. The building is well built throughout with a slate roof, galvanized iron gutters, and concrete floor in the waiting rooms. It was finished inside above the wainscoting with beaver board instead of beaded ceiling or plastering and I believe it is the first station building of its kind that is finished in that way. The finish is very nice and I consider it a very beautiful little station.

Mr. Decker:—We have not built any concrete buildings but use brick altogether on a concrete foundation in our modern stations, and the same construction in our freight and engine houses. We use brick in our platforms. We had several rather important stations, where the brick were laid on edge some years ago. During the last year or so we have taken them up and relaid them flat on a sand cushion without grouting, and so far they have stood up very well. We have not had any trouble with brick breaking except, as Mr. Robinson said, in unloading heavy baggage, if it is dropped on the brick, it will occasionally break a brick.

Mr. Robinson:—I wish to say that we have just covered up some concrete platforms that were laid in 1887 and which have always given us more or less trouble; they cracked in every conceivable way and we had to repair them to keep them in use. Every few years we had to go over them, level them up as best

we could, put a surface over them and plaster them. They were unsightly and were not a success. Where we have raised our tracks in ballasting we have covered them up instead of taking them up and used them simply as foundations for the brick platforms.

Mr. Killam:—All of our freight houses have concrete walls under the office end and concrete columns ten or twelve ft. apart under the freight end. The station houses and all the roundhouses are built on concrete foundations up to the base of the building. We build the station houses of brick. We have no concrete buildings, as brick is more artistic and looks better. We are building a station house just now at Huron and have just finished a freight house that has a concrete foundation and platform. At all the principal stations we have been laying concrete platforms for a number of years and they have given good satisfaction. Of course now and then there is a crack due to the foundation not being properly put in by the contractor, but taking them all together, the concrete platforms are giving excellent satisfaction, and are considered the cheapest and best platforms that we have. Some have been in use ten or eleven years.

Mr. Pickering:—Are they made of cement or entirely of concrete?

Mr. Killam:—They are made of Portland cement and a fine quality of sand with a small portion of stone. Where small failures have occurred the top or finishing coat was not put on quick enough and a block or square has had to be repaired in one or two cases.

Mr. Pickering:—I am deeply interested in this platform question and I would like to ask Mr. Killam first in regard to the foundation for those concrete platforms, and second the approximate cost?

Mr. Killam:—I can not give you the exact cost. The foundation is thoroughly under-drained and dry earth is put down with cinders on that and then a coat of sand, with the concrete on top of that.

Mr. Pickering:—How deep is your base?

Mr. Killam:—We put down two or three feet of dry filling including cinders.

Mr. W. O. Eggleston:—I notice that our line has put down some concrete platforms 30 to 60 ft. long in the last year and a half, without any expansion joints. The platforms are from 10

ft. to 14 ft. wide. Two such platforms that I have seen within the last week, where I know they have been done for a year, show no cracks in them yet. I was told by the parties who did the work, that they put in about two feet of engine cinders, thoroughly rammed and very wet, and placed the concrete mixture on that—I think they said it was about seven inches thick I understood that the concrete was mixed with a continuous mixer, was floated down into a solid, complete mass, and was surfaced with what might be called a scraper which left it in a slightly rough condition,—not polished up at all. The work is good and it has simply been a question with me whether it will stand without cracking. It is under heavy trucking, and a great many people pass over it. We all know that sections four, five or six ft. square, get out of surface and then trouble commences. One cannot patch a concrete platform and make a success of it.

Mr. Killam:—There is just one thing I forgot. Our platforms are put down in three or four ft. squares, separated so they are all disconnected with a finished space of one-half inch between each block, so that cracks don't extend from one to the other.

Mr. Musgrave:—I have had considerable experience in laying concrete platforms and sidewalks, with almost perfect success. I lay a bed of engine cinders from a foot to 16 in. thick, wetting them down well and ramming them to get them solid, then lay concrete five in. thick in blocks in alternate sections and about five or six ft. square. I let them set, take the forms off and use these blocks as forms to lay the other concrete in. I don't believe that a thick topcoat does the concrete any good, providing the topcoat is placed at the same time the bottom is, making an absolute monolith. I have laid 2,200 ft. in one instance, at a cost of 11½ cts. per sq. ft. The sand costs $1 per cu. yd., the gravel $1 and the cement about 40 cts. per sack. That platform has been in now about four years; it has shown absolutely no settling and I don't think there is a crack anywhere in it. They run heavy baggage trucks over that and drop machinery, draw-heads, etc., on it.

Mr. Killam:—We run a little notched roller over the top which makes it rough enough so that there are no complaints of slipping. The last work cost some 19 cts. per sq. ft., which was considered too high, and what was done this year cost 14¾ cts. per sq. ft.

Mr. Eggleston:—One should not rough up concrete with any

kind of a tool after it has had its initial set, for if he does he will destroy part of its durability. You will notice sidewalks that have been smoothed down with a trowel, and which are full of hair cracks that I believe are caused by disturbing it after the initial set.

Mr. Robinson:—Our experience is that the more one trowels a sidewalk, the better he gets it, the same as a floor. If one don't trowel it thoroughly, he don't get a good wearing surface. Our sidewalks have a mixture of four inches of 1 : 3 : 6, concrete, with a top coating of one inch of 1 : 2 mortar (one part cement and two parts of washed torpedo sand). There is a difference between sidewalks and station platforms. We have built, in the city of Peoria, within the last two months, three-quarters of a mile of sidewalk five feet wide, for ten cents a square foot, but we would not use such construction for a railroad platform. I claim that the construction must be heavier, as the conditions of service on railroad platforms are entirely different from those of a sidewalk. A sidewalk is narrow and well drained, while a depot platform is not, unless artificial drainage is provided. The prices I have heard here are much higher than our brick platforms cost and one cannot repair a cement platform as cheaply as he can a brick platform and make a good job of it. I would like to ask Mr. Eggleston what his seven inch platform cost?

Mr. Eggleston:—I cannot answer the question, as I was not connected with that division except as inspector. About 20 years ago we put in three brick platforms at very busy stations. All three of them were located in county seats. One has about five ft. of engine ashes under it, where there was a big hole under an old wooden platform, and one other had about a foot of filling. We thoroughly rolled and rammed this and then we put on a one-inch coating of sand. We then laid a hard common brick on edge, about seven brick to the square foot, and I am not ashamed to look at any of those three platforms today. They are in almost perfect condition under very severe usage. They were not of vitrified brick, but only good, hard burned common brick that we paid eight dollars a thousand for.

Mr. Robinson:—We had a concrete platform at one of our important stations, where we had to change the grade of the platform on account of ballasting. We were unable to raise that platform and get a surface of any kind. The slabs were so uneven that women especially were liable to trip on them. We dis-

carded that platform and replaced it with brick. The brick platforms we were able to raise at a very low cost, and when the work was done the surface was just as good as before.

The Secretary:—Over ten years ago, when I was acting in the capacity of superintendent of bridges and buildings of the Chicago & Northwestern, at Fond du Lac, Wis., I had charge of the construction of quite a large platform at that place (approximately 12 ft. x 200 ft.) the material of which we termed "cinder concrete." It was composed of cinders, sand and cement. It was given a rough finish on top, but as it wore down the effect of the cinders kept it from becoming smooth, and it never became slippery, unless coated with ice, and in that event any kind of a surface will be slippery. This platform is located between two main tracks, at a junction point, and is used a great deal in transferring baggage, mail, express and passengers and the platform is still in service. This was made in one continuous piece and it never checked to amount to anything. I know of other platforms built of concrete which have been very satisfactory, some of them as far north as the line of the Northern Pacific. While they seem to be satisfactory as far north as that, they would give still better service farther south, where the winters are not so severe.

Where a platform will not be disturbed during its lifetime, I think that concrete will give better service than brick; but if the foundation is liable to settle the one constructed of brick can be put into surface and repaired far more satisfactorily than one built of concrete.

Note: This Association received the title—American Railway Bridge and Building Association—at the 18th annual convention at Washington, D. C., October, 1908. Prior to that time it was called —Association of Railway Superintendents of Bridges and Buildings.

LIST OF ANNUAL CONVENTIONS.

No.	Place.	Date.	Membership.
1	St. Louis, Mo.,	Sept. 25, 1891.	60
2	Cincinnati, Ohio,	Oct. 18-19, 1892.	112
3	Philadelphia, Pa.,	Oct. 17-19, 1893	128
4	Kansas City, Mo.,	Oct. 16-18, 1894	115
5	New Orleans, La.,	Oct. 15-16, 1895	122
6	Chicago, Ill.,	Oct. 20-22, 1896	140
7	Denver, Col.,	Oct. 19-21, 1897	127
8	Richmond, Va.,	Oct. 18-19, 1898	148
9	Detroit, Mich.,	Oct. 17-18, 1899	148
10	St. Louis, Mo.,	Oct. 16-18, 1900	143
11	Atlanta, Ga.,	Oct. 15-17, 1901	171
12	Minneapolis, Minn.,	Oct. 21-23, 1902	195
13	Quebec, Canada,	Oct. 20-22, 1903	223
14	Chicago, Ill.,	Oct. 18-20, 1904	293
15	Pittsburg, Pa.,	Oct. 17-19, 1905	313
16	Boston, Mass.,	Oct. 16-18, 1906	340
17	Milwaukee, Wis.,	Oct. 15-17, 1907	341
18	Washington, D. C.,	Oct. 20-22, 1908	368
19	Jacksonville, Fla.,	Oct. 19-21, 1909	393
20	Denver, Colo.,	Oct. 18-20, 1910	428
21	St. Louis, Mo.,	Oct. 17-19, 1911	499
22	Baltimore, Md.,	Oct. 15-17, 1912	524

	1891-2.	1892-3.	1893-4.	1894-5.
President	O. J. Travis	H. M. Hall	J. E. Wallace	Geo. W. Andrews.
1st. V.-Pres.	H. M. Hall	J. E. Wallace	Geo. W. Andrews	W. A. McGonagle.
2nd. V.-Pres.	J. B. Mitchell	G. W. Hinman	W. A. McGonagle.	L. K. Spafford.
3rd. V.-Pres.	James Stannard.	N. W. Thompson	L. K. Spafford	James Stannard.
4th. V.-Pres.	G. W. Hinman	C. E. Fuller	E. D. Hines	Walter G. Berg.
Secretary	C. W. Gooch	S. F. Patterson	S. F. Patterson	S. F. Patterson.
Treasurer	George M. Reid.	George M. Reid.	George M. Reid	George M. Reid.
Executive Members	W. R. Damon	G. W. Andrews	Q. McNab	James Stannard.
	G. W. Markley.	J. M. Staten	A. S. Markley	James H. Travis.
	W. A. McGonagle	J. M. Caldwell	Floyd Ingram	J. H. Cummin.
	G. W. McGehee.	Q. McNab	James Stannard	R. M. Peck.
	G. W. Turner	Floyd Ingram	James H. Travis	J. L. White.
	J. E. Wallace	A. S. Markley	J. H. Cummin	A. Shane.

	1895-6.	1896-7.	1897-8.	1898-9.
President	W. A. McGonagle	James Stannard.	Walter G. Berg	J. H. Cummin.
1st. V.-Pres.	L. K. Spafford.	Walter G. Berg.	J. H. Cummin	A. S. Markley.
2nd. V.-Pres.	James Stannard.	J. H. Cummin	A. S. Markley	C. C. Mallard.
3rd. V.-Pres.	Walter G. Berg.	A. S. Markley	G. W. Hinman	W. A. Rogers.
4th. V.-Pres.	J. H. Cummin.	R. M. Peck	C. C. Mallard	J. M. Staten.
Secretary	S. F. Patterson.	S. F. Patterson	S. F. Patterson	S. F. Patterson.
Treasurer	George M. Reid.	N. W. Thompson	N. W. Thompson	N. W. Thompson.
	R. M. Peck	W. O. Eggleston	G. J. Bishop	Wm. S. Danes.
Executive Members	J. L. White	W. M. Noon	C. P. Austin	J. H. Markley.
	A. Shane	J. M. Staten	M. Riney	W. O. Eggleston.
	A. S. Markley	G. J. Bishop	Wm. S. Danes	R. L. Heflin.
	W. M. Noon	C. P. Austin	J. H. Markley	F. W. Tanner.
	J. M. Staten	M. Riney	W. O. Eggleston	A. Zimmerman.

	1899-1900.	1900-1901.	1901-1902.	1902-1903.
President	Aaron S. Markley	W. A. Rogers	W. S. Danes	B. F. Pickering.
1st. V.-Pres.	W. A. Rogers	W. S. Danes	B. F. Pickering	C. C. Mallard.
2nd. V.-Pres.	J. M. Staten	B. F. Pickering.	A. Shane	A. Shane.
3rd. V.-Pres.	Wm. S. Danes	A. Shane	A. Zimmerman	A. Zimmerman.
4th. V.-Pres.	B. F. Pickering	A. Zimmerman	C. C. Mallard	A. Montzheimer.
Secretary	S. F. Patterson	S. F. Patterson.	S. F. Patterson	S. F. Patterson.
Treasurer	N. W. Thompson	N. W. Thompson	N. W. Thompson.	N. W. Thompson.
Executive Members	T. M. Strain	T. M. Strain	A. Montzheimer	W. E. Smith.
	R. L. Heflin	H. D. Cleaveland.	W. E. Smith	A. W. Merrick.
	F. W. Tanner	F. W. Tanner	A. W. Merrick	C. P. Austin.
	A. Zimmerman	A. Montzheimer.	C. P. Austin	C. A. Lichty.
	H. D. Cleaveland	W. E. Smith	C. A. Lichty	W. O. Eggleston.
	A. Montzheimer.	A. W. Merrick	W. O. Eggleston.	J. H. Markley.

	1903-1904.	1904-1905.	1905-1906.	1906-1907.
President	A. Montzheimer	C. A. Lichty	J. B. Sheldon	J. H. Markley.
1st. V.-Pres.	A. Shane	J. B. Sheldon	J. H. Markley	R. H. Reid.
2nd. V.-Pres.	C. A. Lichty	J. H. Markley	R. H. Reid	J. P. Canty.
3rd. V.-Pres.	J. B. Sheldon	R. H. Reid	R. C. Sattley	H. Rettinghouse.
4th. V.-Pres.	J. H. Markley	R. C. Sattley	J. P. Canty	F. E. Schall.
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson.
Treasurer	C. P. Austin	C. P. Austin	C. P. Austin	C. P. Austin.
Executive Members	R. H. Reid	W. O. Eggleston	H. Rettinghouse	W. O. Eggleston.
	W. O. Eggleston	A. E. Killam	A. E. Killam	A. E. Killam.
	A. E. Killam	H. Rettinghouse.	J. S. Lemond	J. S. Lemond.
	R. C. Sattley	J. S. Lemond	C. W. Richey	C. W. Richey.
	H. Rettinghouse	W. H. Finley	H. H. Eggleston.	H. H. Eggleston.
	J. S. Lemond	C. W. Richey	F. E. Schall	B. J. Sweatt.

	1907-1908.	1908-1909.	1909-1910.	1910-1911.
President	R. H. Reid......	J. P. Canty	J. S. Lemond...	H. Rettinghouse
1st. V.-Pres. .	J. P. Canty.....	H. Rettinghouse..	H. Rettinghouse.	F. E. Schall
2nd. V.-Pres.	H. Rettinghouse..	F. E. Schall.....	F. E. Schall....	A. E. Killam
3rd. V.-Pres.	F. E. Schall	J. S. Lemond....	A. E. Killam...	J. N. Penwell
4th. V.-Pres. .	W. O. Eggleston.	A. E. Killam....	J. N. Penwell..	L. D. Hadwen .
Secretary	S. F. Patterson..	S. F. Patterson..	C. A. Lichty....	C. A. Lichty
Treasurer	C. P. Austin....	C. P. Austin....	J. P. Canty....	J. P. Canty
Executive Members .	A. E. Killam....	J. N. Penwell....	W. Beahan	T. J. Fullem
	J. S Lemond.....	Willard Beahan ..	F. B. Scheetz .	G. Aldrich
	C. W. Richey....	F. B. Scheetz...	L. D. Hadwen ..	P. Swenson
	T. S. Leake......	W. H. Finley...	T. J. Fullem...	G. W. Rear
	W. H. Finley....	L. D. Hadwen ..	G. Aldrich......	W. O. Eggleston.
	J. N. Penwell....	T. J. Fullem....	P. Swenson.....	W. F. Steffens

	1911-1912.	1912-1913.		
President	F. E. Schall	A. E. Killam....		
1st. V.-Pres. .	A. E. Killam ...	J. N. Penwell...		
2nd. V.-Pres.	J. N. Penwell ...	L. D. Hadwen...		
3rd. V.-Pres.	L. D. Hadwen ..	T. J. Fullem....		
4th. V.-Pres. .	T. J. Fullem	G. Aldrich		
Secretary	C. A. Lichty	C. A. Lichty.....		
Treasurer	J. P. Canty	J. P. Canty......		
Executive Members .	G. Aldrich	G. W. Rear....		
	P. Swenson	W. F. Steffens...		
	G. W. Rear	E. B. Ashby....		
	W. F. Steffens ..	C. E. Smith....		
	E. B. Ashby	S. C. Tanner....		
	W. O. Eggleston	Lee Jutton		

CONSTITUTION

ARTICLE I.

NAME.

SECTION 1. This association shall be known as the American Railway Bridge & Building Association.

ARTICLE II.

OBJECT.

SECTION 1. The object of this association shall be the advancement of knowledge pertaining to the principles, design, construction and maintenance of railway bridges, buildings and other structures, by investigation, reports and discussion of the experience of its members and others, and to provide a means of exchange of ideas, so that bridge and building practice may be systematized and improved.

SECT. 2. The association shall neither endorse nor recommend any particular patents, materials or supplies, but individual opinions of members may be expressed and appear in the proceedings.

ARTICLE III.

MEMBERSHIP.

SECTION 1. The membership of this association shall consist of two classes, active and life members.

SECT. 2. A person who is actively engaged in railway service in a responsible position, in charge of work connected with the construction or maintenance of railway bridges and buildings or other structures, or a professor of engineering, government timber expert, or railroad architect shall be eligible for active membership upon application to the secretary, and the payment of three dollars membership fee, and two dollars for one year's dues.

SECT. 3. Any member elected a life member of this association shall have all the privileges of an active member, but shall not be required to pay annual dues. To be elected a life member he must have been a member of the association at least five years and before being elected must have been pensioned by the railway company for which he worked or shall have retired from active railway service.

SECT. 4. Any member guilty of dishonorable conduct, or conduct unbecoming a railroad official and member of this association, or who shall refuse to obey the chairman, or rules, may be expelled by a two-thirds vote of the members present.

SECT. 5. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled.

ARTICLE IV.

OFFICERS.

SECTION 1. The officers of this association shall be a president, four vice-presidents, a secretary, a treasurer, and six executive members.

SECT. 2. The executive members, together with the president, vice-presidents, secretary and treasurer, shall constitute the executive committee.

SECT. 3. Past presidents of this association who continue to be members shall be entitled to be present at all meetings of the executive committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past-presidents shall not have a right to vote, nor shall their presence be requisite in order to constitute a quorum.

SECT. 4. Vacancies in any office for the unexpired term shall be filled by the executive committee without unnecessary delay.

ARTICLE V.

EXECUTIVE COMMITTEE.

SECTION 1. The executive committee shall exercise a general supervision over the financial inteiests of the association, assess the amount of annual and other dues, call, prepare for and conduct general or special meetings, make all necessary purchases and contracts required to conduct the general business of the association, but shall not have the power to render the association liable for any debt beyond the amount then in the treasurer's hands not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the association.

SECT. 2. Two thirds of the members of the executive committee may call special meetings, thirty days' notice being given members by mail.

SECT. 3. Five members of the executive committee shall constitute a quorum for the transaction of business.

ARTICLE VI.

ELECTION OF OFFICERS AND TENURE OF OFFICE.

SECTION 1. The officers, excepting as otherwise provided, shall be elected at the regular meeting of the association, held on the third Tuesday in October of each year, and the election shall not be postponed except by unanimous consent.

SECT. 2. The president and treasurer shall be elected by ballot by a majority of votes cast, and shall hold office for one year or until successors are elected. No member in arrears shall be eligible for office, and the president shall not be eligible for reelection.

Vice-Presidents and Executive Members.

SECT. 3. The vice-presidents shall hold office for one year and executive members for two years; four vice-presidents and three executive members to be elected each year; all officers herein named to hold office until successors are chosen.

SECT. 4. In the election of vice-presidents, each one shall be elected by a majority vote. Executive members shall be elected in the same way, all voting to be by written ballots.

Secretary.

SECT. 5. A secretary shall be elected by a majority of the votes of the members present at the annual meeting. The term of office of the secretary shall be for one year, unless terminated sooner by action of the executive committee, two thirds of whom may remove the secretary at any time. His compensation shall be fixed by a majority of the executive committee. The secretary shall also be secretary of the executive committee.

Treasurer.

SECT. 6. The treasurer shall be required to give bond in an amount to be fixed by the majority of the executive committee.

ARTICLE VII.

COMMITTEES.

Nominating Committee.

SECTION 1. After each annual meeting the president shall appoint a committee of five members, not officers of the association, of whom two at least shall be past presidents, and two of whom shall have served on the committee the previous year. They shall prepare a list of names of nominees for officers to be voted on at the next annual convention, agreeable to Article VI. of this constitution, said list to be read at the first session of the second day of said convention. Nothing in this section shall be construed to prevent any member making nominations.

Auditing Committee.

SECT. 2. At the first session of each annual meeting there shall be appointed by the president an auditing committee of three members, not officers of the association, whose duty it shall be to examine the accounts and vouchers of the secretary and treasurer and certify as to the correctness of their accounts. Acceptance of this committee's report will be regarded as the discharge of the committee.

Committee on Subjects for Discussion.

SECT. 3. At the annual meeting there shall be appointed, by the president, a committee, whose duty it shall be to prepare and report subjects for investigation and discussion at the next annual meeting. It shall be the duty of the committee to receive from members questions for discussion during the time set apart for that purpose. This committee shall decide whether such questions are suitable ones for discussion, and if approved, report them to the association.

Committees on Investigation.

SECT. 4. When the committee on subjects has reported and the association approved of the same, the president shall appoint special committees to investigate and report on said subjects and he may appoint a special committee to investigate and report on any subject of which a majority of members present may approve.

Publication Committee.

SECT. 5. After each annual meeting the executive committee shall appoint a publication committee of three active members whose duty it shall be to supervise the publication of the proceedings. The assignment of this committee shall be such that at least one member shall have served on the committee during the previous year. The publication committee will report to the president and perform their duties under his supervision.

ARTICLE VIII.

ANNUAL DUES.

SECTION 1. Every active member shall pay to the secretary three dollars membership fee and shall also pay two dollars per year in advance to defray the necessary expenses of the association. No member being one year in arrears for dues shall be entitled to vote at any election, and any member one year in arrears may be stricken from the list of members at the discretion of the executive committee.

ARTICLE IX.

AMENDMENTS.

SECTION 1. This constitution may be amended at any regular meeting by a two thirds vote of members present, provided that a written notice of the proposed amendment, or amendments, has been given at least sixty days previous to said regular meeting.

BY-LAWS

TIME OF MEETING.

1. The regular meeting of this association shall be held annually on the third Tuesday in October.

HOUR OF MEETING.

2. The regular hour of meeting shall be at 10 o'clock a. m., unless changed by order of the presiding officer.

PLACE OF MEETING.

3. The cities or places for holding the annual convention may be proposed at any regular meeting of the association before the final adjournment. The places proposed shall be submitted to a ballot vote of the members of the association, the city or place receiving a majority of all the votes cast to be declared the place of the next annual meeting; but if no place received a majority of all votes, then the place receiving the lowest number of votes shall be dropped on each subsequent ballot until a place is chosen.

QUORUM

4. At the regular meeting of the association, fifteen or more members shall constitute a quorum.

ORDER OF BUSINESS.

5. 1st—Calling of roll.
   2nd—Reading minutes of last meeting.
   3rd—Admission of new members.
   4th—President's address.
   5th—Reports of secretary and treasurer.
   6th—Payment of annual dues.
   7th—Appointment of committees.
   8th—Reports of committees.
   9th—Unfinished business.
   10th—New business.
   11th—Reading and discussion of questions propounded by members.
   12th—Miscellaneous business.
   13th—Election of officers.
   14th—Adjournment.

(Report of nominating committee to be read at first session of second day.)

DUTIES OF OFFICERS.

6. The president shall have general supervision of the affairs of the association. He shall preside at all meetings of the asso-

ciation, and of the executive committee, at which he may be present; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. He shall, with the secretary, sign all contracts or other written obligations of the association which have been approved by the executive committee.

At the annual meeting the president shall present a report containing a statement of the general condition of the association, and an address.

7. The vice-presidents in order of seniority shall preside at meetings in the absence of the president, and discharge his duties in case of a vacancy in his office.

8. It shall be the duty of the secretary to keep a correct record of proceedings of all meetings of this association; to keep correct all accounts between this association and its members; collect all moneys due the association, and pay the same over to the treasurer and take his receipt therefor, and to perform such other duties as the association may require.

9. The treasurer shall receive all moneys and deposit the same in the name of the association and shall receipt to the secretary therefor. He shall invest all funds not needed for current disbursements as shall be ordered by the executive committee. He shall pay all bills, when properly certified and approved by the president, and make such reports as may be called for by the executive committee.

DECISIONS.

10. The votes of a majority of members present shall decide any question, motion or resolution which shall be brought before the association, unless otherwise provided.

DISCUSSIONS.

11. All discussions shall be governed by Robert's rules of order.

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Findley, A., 929 Wash. Ave., Portland, Me.
Forbes, Jno., 45 Victoria Road, Halifax, N. S.
Foreman, John, P. & R. Ry., Pottstown, Pa.
Gooch, C. W., 1325 W. 9th St., Des Moines, Ia.
Green, E. H. R., Texas Midland R. R., Terrell, Tex.
Hubbard, A. B., B. & M. R. R., Boston, Mass.
Lydston, W. A., B. & M. R. R., Salem, Mass.
McIntyre, James, Miami, Fla.
McLean, Neil, Mast. Carp., Erie R. R., Huntington, Ind.
Mountain, G. A., Ch. Engr., Ry. Com. of Canada, Ottawa, Ont.
Noon W. M., Palatka, Fla.
Patterson, S. F., B. & M. R. R., Concord, N. H.
Porter, L. H., Box 35, Andover, Conn.
Stannard, Jas., 1602 Broadway, Kansas City, Mo.
Travis, O. J., Box 11, Lowell, Wash.
Vandegrift, C. W., C. & O. Ry., Ronceverte, W. Va.
Wells, J. M., Chillicothe, Ill.
Wise, E. F., 207 Clay St., Waterloo, Ia.

DECEASED MEMBERS.

Amos, A.,
Berg, Walter G.
Bishop, Geo. J.
Blair, J. A.
Brady, James.
Carr, Charles.
Causey, T. A.
Cleaveland, H. D.
Costolo, J. A.
Crane, Henry
DeMars, James.
Dunlap, H.
Fletcher, H. W.
Fuller, C. E.
Gilbert, J. D.
Gilchrist, E. M.
Graham, T. B.
Hall, H. M.
Heflin, R. L.
Henson, H. M.
Hinman, G. W.
Humphreys, Thos.
Isadell, L. S.
Johnson, J. E.
Keen, Wm. H.
Lantry, J. F.
Large, C. M.
Larson, G.
Lovett, J. W.
Markley, Abel S.
McCormack, J. W.
McGehee, G. W.
Mellor, W. J.
Millner, S. S.
Mitchell, J. B.
Mitchell, W. B.
Morgan, T. H.
Morrill, H. P.
Peck, R. M.
Perry, W. W.
Phillips, W. H.
Powell, W. T.
Reid, G. M.
Renton, Wm.
Reynolds, E. F.
Robertson, Daniel
Schwartz, J. C.
Spafford, L. K.
Spangler, J. A.
Spaulding, E. C.
Spencer, C. F.
Taylor, J. W.
Thompson, N. W.
Tozzer, Wm. S.
Trautman, T. J.
Van Der Hoek, J.
Wallace, T. E.
Walden, W. D.
Welch, E. T.
Wood, W. B.
Worden, C. G.

MEMBERSHIP AND MILEAGE OF RAILWAYS REPRESENTED.

Name of Road and Membership.	Members.	Mileage.
Alberta Interurban Ry.,	2	10
V. A. Newhall, Calgary, Alta.		
K. J. C. Zinck, Calgary, Alta.		
Algoma Central & Hudson Bay Ry.	1	116
R. S. McCormick, Sault Ste. Marie, Ont.		
Arizona Eastern R. R.	1	355
C. C. Mallard, Globe, Ariz.		
Atchison, Topeka & Santa Fé Ry	5	5,848
A. J. James, Topeka, Kans.		
E. McCann, Wellington, Kan.		
John L. Talbott, Pueblo, Col.		
J. M. Wells, Chillicothe, Ill.		
M. R. Williams, Las Vegas, N. M.		
Atchison, Topeka & Santa Fé Ry. (Coast Lines)	5	2,022
E. E. Ball, Winslow, Ariz.		
J. F. Parker, San Bernardino, Cal.		
V. C. Proctor, Winslow, Ariz.		
D. A. Shope, Fresno, Cal.		
J. W. Wood, Needles, Cal.		
Atlanta & West Point R. R. and W. Ry. of Ala.	2	225
O. T. Nelson, Montgomery, Ala.		
J. C. Williams, Opelika, Ala.		
Atlantic Coast Line R. R.	1	4,500
J. W. Salisbury, Port Tampa, Fla.		
Baltimore & Ohio R. R. and B. & O. S. W. R. R.	21	4,738
G. W. Andrews, Baltimore, Md.		
S. H. Blowers, Columbus, O.		
W. S. Bouton, Baltimore, Md.		
Z. T. Brantner, Martinsburg, W. Va.		
H. R. Bricker, Baltimore, Md.		
W. M. Clark, Pittsburgh, Pa.		
W. R. Edwards, Baltimore, Md.		
W. T. Hopke, Grafton, W. Va.		
E. G. Lane, Baltimore, Md.		
M. A. Long, Baltimore, Md.		
B. S. Mace, Baltimore, Md.		
J. T. McIlwain, Akron, O.		
E. G. Moore, Grafton, W. Va.		
J. O. Potts, Baltimore, Md.		
W. S. Schenck, Connellsville, Pa.		
W. F. Strouse, Baltimore, Md.		
S. C. Tanner, Baltimore, Md.		

Name of Road and Membership.	Members.	Mileage
Baltimore & Ohio R. R. and B. & O. S. W. R. R. Continued.		
D. B. Taylor, Garrett, Ind.		
F. A. Taylor, Cumberland, Md.		
T. E. Thomas, Wilmington, Del.		
E. C. Zinsmeister, Zanesville, O.		
Baltimore & Ohio, Chicago Terminal R. R.	1	289
H. H. Eggleston, Chicago.		
Bangor & Aroostook R. R.	2	628
W. E. Alexander, Houlton, Me.		
M. Burpee, Houlton, Me.		
Bessemer & Lake Erie R. R.	1	210
Boston & Albany R. R.	2	392
W. F. Steffens, Boston, Mass.		
W. C. Whitney, Boston, Mass.		
Boston & Maine R. R.	14	2,288
Cyrus P. Austin, Medford, Mass.		
C. C. Battey, Concord, N. H.		
J. P. Canty, Fitchburg, Mass.		
John Ewart, Boston, Mass.		
Andrew B. Hubbard, Boston, Mass.		
F. J. Leavitt, Salem, Mass.		
William A. Lydston, Salem, Mass.		
John Marsh, Lawrence, Mass.		
Albert Mountfort, Nashua, N. H.		
A. A. Page, Concord, N. H.		
S. F. Patterson, Concord, N. H.		
B. F. Pickering, Salem, Mass.		
Fred C. Rand, Boston, Mass.		
F. A. Sherwin, St. Johnsbury, Vt.		
Brazil Ry.	1	10,000
A. M. Dodd, Sao Paulo, Brazil, S. A.		
Canadian Pacific Ry.	3	10,832
F. P. Gutelius, Montreal, P. Q.		
Frank Lee, Winnipeg, Man.		
D. A. McRae, Cranbrook, B. C.		
Carolina & Northwestern Ry.	1	133
J. W. Fletcher, Jr., Chester, S. C.		
Central of Georgia Ry.	1	1,916
H. C. McKee, Macon, Ga.		
Central Vermont Ry.	3	536
C. Donaldson, Waterbury, Vt.		
C. F. Flint, St. Albans, Vt.		
H. E. Holmes, New London, Conn.		
Chesapeake & Ohio Ry.	5	2,027
F. M. Griffith, Covington, Ky.		
Oscar L. Grover, Richmond, Va.		
C. E. Powell, Hinton, W. Va.		
J. M. Staten, Richmond, Va.		
C. W. Vandegrift, Ronceverte, W. Va.		

Name of Road and Membership.	Members.	Mileage
Chicago & Alton R. R.	1	1,025
C. A. Stelle, Bloomington, Ill.		
Chicago & Eastern Illinois R. R.	1	1,266
A. S. Markley, Danville, Ill.		
Chicago & North Western Ry.	29	8,101
L. J. Anderson, Escanaba, Mich.		
H. Bender, Eagle Grove, Ia.		
W. A. Brewer, Clyman, Wis.		
F. L. Burrell, Fremont, Neb.		
F. M. Case, Belle Plaine, Ia.		
O. F. Dalstrom, Chicago.		
H. H. Decker, Chicago, Ill.		
T. H. Durfee, Huron, S. D.		
W. H. Finley, Chicago, Ill.		
M. J. Flynn, Chicago, Ill.		
G. W. Hand, Chicago, Ill.		
John Hunciker, Chicago, Ill.		
Lee Jutton, Chicago, Ill		
C. F. King, Omaha, Neb.		
C. A. Lichty, Chicago, Ill.		
George Loughnane, Escanaba, Mich.		
W. T. Main, Chicago, Ill.		
C. A. Marcy, Chicago, Ill.		
W. F. Meyers, Belle Plaine, Ia.		
J. D. Moen, Boone, Ia.		
J. A. S. Redfield, Fond du Lac, Wis.		
H. Rettinghouse, Mason City, Ia.		
R. W. Richardson, Sioux City, Ia.		
M. Riney, Baraboo, Wis.		
J. S. Robinson, Chicago, Ill.		
D. Rounseville, Antigo, Wis.		
Wm. Spencer, Chadron, Nebr.		
W. M. Sweeney, Green Bay, Wis.		
J. B. White, Boone, Ia.		
Chicago, Burlington & Quincy R. R.	4	9,075
W. E. Elder, Burlington, Ia.		
Geo. Fenney, McCook, Neb.		
W. Hurst, St. Joseph, Mo.		
C. J. Scribner, Chicago.		
Chicago Great Western R. R.	2	1,492
W. L. Derr, Clarion, Ia.		
H. A. Elwell, Clarion, Ia.		
Chicago, Indianapolis & Louisville Ry.	1	578
J. M. Caldwell, Lafayette, Ind.		
Chicago, Milwaukee & St. Paul Ry.	15	9,585
(and C. M. & P. S. Ry.)		
E. J. Auge, Wells, Minn.		
A. G. Bennett, Minneapolis, Minn.		
E. E. Clothier, Perry, Ia.		
H. R. Drum, Chamberlain, S. D.		
L. D. Hadwen, Chicago, Ill.		
F. E. King, Minneapolis, Minn.		
N. H. LaFountain, Chicago, Ill.		

Name of Road and Membership.	Members.	Mileage
Chicago, Milwaukee & St. Paul Ry. Continued.		
C. F. Loweth, Chicago, Ill.		
E. S. Meloy, Chicago.		
Edw. Murray, Miles City, Mont.		
William Ross, Milbank, S. D.		
Fred E. Weise, Chicago, Ill.		
William E. Wood, Chicago, Ill.		
A. A. Wolf, Milwaukee, Wis.		
A. Yappen, Chicago, Ill.		
Chicago, Rock Island & Pacific Ry.	8	7,551
McClellan Bishop, El Reno, Okla.		
C. H. Eggers, Little Rock, Ark.		
E. R. Floren, Rock Island, Ill.		
Guy Gordon, Little Rock, Ark.		
M. E. Gumphrey, Eldon, Mo.		
W. V. Parker, Amarillo, Tex.		
R. C. Sattley, Chicago.		
R. Wagner, Little Rock, Ark.		
Chicago, St. Paul, Minneapolis & Omaha Ry.	2	1,744
A. G. Rask, Spooner, Wis.		
Aug. Ruge, Mankato, Minn.		
Chicago, Terre Haute & Southern Ry.	2	351
J. Dupree, Crete, Ill.		
J. O. Jewell, Terre Haute, Ind.		
Cincinnati, Hamilton & Dayton Ry.	1	1,015
I. F. White, Dayton, O.		
Cincinnati Northern R. R.	1	236
J. M. Wilkinson, Van Wert, O.		
Colorado & Southern Ry.	4	1,250
R. W. Beeson, Trinidad, Colo.		
C. W. Fellows, Denver, Colo.		
Harry James, Denver, Colo.		
A. W. Pauba, Denver, Colo.		
Colorado Midland Ry.	1	338
J. Guretzky, Colorado City, Colo.		
Columbia, Newberry & Laurens R. R.	1	75
A. P. Rice, Columbia, S. C.		
Concho, San Saba & Llano Valley R. R.	1	61
K. S. Hull, Temple, Tex.		
Copper Range R. R.	1	150
A. Giesing, Houghton, Mich.		
Delaware, Lackawanna & Western R. R.,	7	985
F. J. Arnold, Scranton, Pa.		
G. E. Boyd, Scranton, Pa.		
E. Cahill, Binghamton, N. Y.		
C. G. Connolly, Scranton, N. Y.		
A. McQueen, Binghamton, N. Y.		
J. E. Ranney, Buffalo, N. Y.		
Jas. Skeoch, Dunmore, Pa.		

Name of Road and Membership.	Members.	Mileage
Denver & Rio Grande R. R.	6	2,598
G. W. Kinney, Salt Lake City.		
A. Ridgway, Denver, Colo.		
A. C. Snyder, Salt Lake City.		
H. Taylor, Alamosa, Colo.		
C. S. Thompson, Denver, Colo.		
Jas. Vaughan, Salida, Colo.		
Duluth & Iron Range R. R.	2	168
W. A. Clark, Duluth, Minn.		
B. T. McIver, Two Harbors, Minn.		
Duluth, Missabe & Northern Ry.	1	297
W. A. McGonagle, Duluth, Minn.		
Elgin, Joliet & Eastern Ry.	3	770
G. H. Jennings, Joliet, Ill.		
A. Montzheimer, Joliet, Ill.		
C. Thompson, Joliet, Ill.		
Erie R. R. (and Chicago & Erie)	7	2,665
O. F. Barnes, Susquehanna, Pa.		
W. O. Eggleston, Huntington, Ind.		
A. J. Horth, Meadville, Pa.		
F. A. Knapp, Jersey City, N. J.		
W. H. Matthews, Hornell, N. Y.		
Neil McLean, Huntington, Ind.		
W. H. Wilkinson, Elmira, N. Y.		
Florida East Coast Ry.	2	708
E. K. Barrett, St. Augustine, Fla.		
A. M. Van Auken, St. Augustine, Fla.		
Fort Smith & Western R. R.	1	217
B. F. Beckman, Ft. Smith, Ark.		
Fort Worth & Denver City Ry.	1	454
J. M. Mann, Ft. Worth, Tex.		
Georgia & Florida Ry.	1	325
W. A. Swallow, Augusta, Ga.		
Grand Rapids & Indiana Ry.	2	592
W. S. McKeel, Grand Rapids, Mich.		
H. M. Large, Ft. Wayne, Ind.		
Grand Trunk Ry. System	6	4,756
J. B. Gaut, Montreal, Que.		
J. Henderson, St. Thomas, Ont.		
George A. Mitchell, Toronto, Ont.		
H. C. Swartz, St. Thomas, Ont.		
J. E. Travis, Toronto, Ont.		
C. F. Warcup, St. Thomas, Ont.		
Grand Trunk Pacific Ry.	1	2,440
L. H. Wheaton, Dartmouth, N. S.		
Gulf, Colorado and Santa Fé Ry.	4	1,603
E. C. George, Beaumont, Tex.		
K. S. Hull, Temple, Tex.		
W. G. Massenburg, Beaumont, Tex.		
W. W. Wilson, Galveston, Tex.		

Name of Road and Membership.	Members.	Mileage
Hampshire Southern R. R.	1	38
W. Trapnell, Romney, W. Va.		
Illinois Central R. R.	11	4,755
P. Aagaard, Chicago, Ill.		
F. O. Draper, Chicago, Ill.		
C. Ettinger, Chicago.		
T. J. Fullem, Chicago, Ill.		
C. R. Knowles, Chicago.		
R. J. McKee, Freeport, Ill.		
Samuel P. Munson, Mattoon, Ill.		
William Reed, Grenada, Miss.		
C. E. Thomas, Chicago, Ill.		
F. L. Thompson, Chicago, Ill.		
E. F. Wise (retired), Waterloo, Ia.		
Illinois Traction System	1	420
G. A. Wright, Decatur, Ill.		
Indianapolis, Columbus & Southern Traction Co.	1	62
A. Shane, Columbus, Ind.		
Intercolonial Ry.	7	1,468
T. C. Burpee, Moncton, N. B.		
Hugh Jardine, Moncton, N. B.		
A. E. Killam, Moncton, N. B.		
H. J. McGrath, Moncton, N. B.		
W. B. McKenzie, Moncton, N. B.		
Thomas Sefton, Moncton, N. B.		
A. C. Selig, Moncton, N. B.		
International & Great Northern Ry.	1	1,106
H. M. Jack, Palestine, Tex.		
Kansas City, Clinton & Springfield Ry.	1	155
J. B. Browne, Clinton, Mo.		
Kansas City Southern Ry.	2	762
C. E. Johnston, Kansas City, Mo.		
J. J. Taylor, Texarkana, Tex.		
Lake Erie & Western Ry.	2	882
P. P. Lawrence, Tipton, Ind.		
J. N. Penwell, Tipton, Ind.		
Lake Shore & Michigan Southern Ry.	4	1,775
Willard Beahan, Cleveland, O.		
Philip O'Neill, Adrian, Mich.		
R. H. Reid, Cleveland, O.		
J. L. Soisson, Norwalk, O.		
Lake Superior & Ishpeming Ry., Munising Ry., and Marquette & S. E. Ry.	2	160
August Anderson, Marquette, Mich		
Roscoe C. Young, Marquette, Mich.		
Lehigh & Hudson River Railway	1	96
J. E. Barrett, Warwick, N. Y.		
Lehigh & New England R. R.	1	170
W. E. Harwig, Bethlehem, Pa.		

Name of Road and Membership.	Members.	Mileage
Lehigh Valley R. R.	9	1,446
E. B. Ashby, New York City.		
Peter Hofecker, Auburn, N. Y.		
J. W. Holcomb, Buffalo, N. Y.		
Judson Joslin, Auburn, N. Y.		
David A. Keefe, Athens, Pa.		
A. E. Kemp, Hazleton, Pa.		
F. E. Schall, South Bethlehem, Pa.		
L. W. Swan, Easton, Pa.		
E. R. Wenner, Ashley, Pa.		
Long Island R. R.	4	392
W. F. O'Connor, Flushing, N. Y.		
Chas. Wehlen, Jamaica, N. Y.		
W. Wicks, Amityville, N. Y.		
C. W. Wright, Jamaica, N. Y.		
Louisiana & Arkansas Ry.	1	255
W. H. Vance, Stamps, Ark.		
Louisville & Nashville R. R. (and Nash. Term. Co.)	11	4,728
J. M. Bibb, Birmingham, Ala.		
A. J. Catchot, Ocean Springs, Miss.		
R. O. Elliott, Nashville, Tenn.		
H. R. Hill, Birmingham, Ala.		
Floyd Ingram, Erin, Tenn.		
J. W. Little, Birmingham, Ala.		
A. B. McVay, Evansville, Ind.		
C. M. Roy, Birmingham, Ala.		
Wm. Sheley, Evansville, Ind.		
H. Stamler, Paris, Ky.		
W. G. Stewart, Nashville, Tenn.		
Maine Central R. R.	1	1,180
P. N. Watson, Brunswick, Me.		
Michigan Central R. R.	4	1,803
S. D. Bailey, Detroit, Mich.		
Thomas Hall, St. Thomas, Ont.		
Henry A. Horning, Jackson, Mich.		
J. T. Webster, St. Thomas, Ont.		
Minneapolis & St. Louis R. R.	2	1,586
Ed. Gagnon, Minneapolis, Minn.		
G. S. Kibbey, Minneapolis, Minn.		
Minneapolis, St. Paul & Sault Ste. Marie Ry.	2	3,770
P. Swenson, Minneapolis, Minn.		
G. A. Manthey, Minneapolis, Minn.		
Miss. River & Bonne Terre Ry.	1	64
C. H. Fake, Bonne Terre, Mo.		
Missouri, Kansas & Texas Ry.	1	3,073
A. S. Clopton, Parsons, Kans.		
Missouri Pacific Ry. System (including St. Louis, Iron Mountain & Southern Ry.)	19	7,231
E. E. Allard, St. Louis, Mo.		
Robert J. Bruce, St. Louis, Mo.		
E. M. Dolan, St. Louis, Mo.		
A. H. Ferdina, St. Louis, Mo.		
C. Gnadt, Poplar Bluff, Mo.		

Name of Road and Membership.	Members.	Mileage
Missouri Pacific Ry. System. Continued.		
Lon Graves, Dermott, Ark.		
W. Hausgen, Sedalia, Mo.		
E. P. Hawkins, Bastrop, La.		
W. J. Lacy, Poplar Bluff, Mo.		
G. W. Land, McGehee, Ark.		
C. E. Redmond, Van Buren, Ark.		
C. E. Smith, St. Louis, Mo.		
E. A. Stanley, St. Louis, Mo.		
Wm. Sullivan, Kansas City, Mo.		
F. W. Tanner, St. Louis, Mo.		
L. J. Wackerle, Osawatomie, Kans.		
A. L. Waits, St. Louis, Mo.		
C. H. Walther, Poplar Bluff, Mo.		
Mobile & Ohio R. R.	2	1,114
W. B. Harris, Murphysboro, Ill.		
B. F. Whiting, Murphysboro, Ill.		
Nashville, Chattanooga & St. Louis Ry.	1	1,230
I. O. Walker, Paducah, Ky.		
National Rys. of Mexico	1	6,177
Hans Bentele, Mexico City, Mex.		
New South Wales Government Rys.	1	3,472
James Fraser, Sydney, N. S. W.		
ew York Central & Hudson River R. R.	10	2,829
J. K. Bonner, Rochester, N. Y.		
U. S. Hitesman, New York City.		
G. J. Klumpp, Rochester, N. Y.		
R. P. Mills, New York City.		
Kemper Peabody, N. Y. City.		
W. A. Pettis, Rochester, N. Y.		
John Schaffer, Rochester, N. Y.		
H. C. Thompson, Weehawken, N. J.		
C. C. Warne, New York City.		
E. E. Wilson, New York City.		
w York, New Haven & Hartford R. R.	11	2091
Grosvenor Aldrich, Readville, Mass.		
J. S. Browne, Providence, R. I.		
Wm. Graham, New Haven, Conn.		
H. H. Kinzie, Taunton, Mass.		
Wm. H. Moore, New Haven, Conn.		
B. P. Phillips, Willimantic, Conn.		
L. H. Porter (retired), Andover, Conn.		
George A. Rodman, New Haven, Conn.		
George T. Sampson, Boston, Mass.		
D. W. Sharpe, New Haven, Conn.		
J. B. Sheldon, Providence, R. I.		
York, Ontario & Western R. R.	1	494
J. H. Nuelle, Middletown, N. Y.		
Zealand Government Rys.	2	2,717
C. H. Biss, Christchurch, N. Z.		
George A. Troup, Wellington, New Zealand.		

Name of Road and Membership.	Members.	Mileage
Northern Pacific Ry.	5	6,029
James Hartley, Staples, Minn.		
F. Ingalls, Jamestown, N. D.		
C. S. McCully, Jamestown, N. D.		
R. E. McFarlane, Duluth, Minn.		
J. C. Taylor, Glendive, Mont.		
North Western Govt. Rys. (India)	1	4,431
D. M. Cookson, Kalaw, Burma, India.		
Northwestern Pacific R. R.	1	469
A. A. Robertson, San Rafael, Cal.		
Oregon Short Line R. R.	15	1,752
D. H. Ashton, Salt Lake City.		
Robt. Barr, Pocatello, Idaho.		
J. F. Cullen, Pocatello, Idaho.		
W. C. Dale, Salt Lake City.		
J. S. Eastman, Idaho Falls, Idaho.		
O. Forsgren, Brigham, Utah.		
C. J. Harris, Idaho Falls, Idaho.		
A. H. King, Salt Lake City, Utah.		
C. T. Musgrave, Idaho Falls, Idaho.		
P. E. Parsons, Salt Lake City.		
S. J. Powell, Ogden, Utah.		
A. W. Robinson, Salt Lake City.		
R. B. Robinson, Salt Lake City.		
A. R. Stevens, Salt Lake City.		
D. T. Wells, Salt Lake City.		
Pacific Electric Ry.	1	570
D. E. Plank, Los Angeles, Cal.		
Pennsylvania Lines West of Pittsburg	8	3,098
Samuel C. Bowers, Steubenville, O.		
Stanton Bowers, Bradford, O.		
B. F. Gehr, Richmond, Ind.		
A. F. Miller, Chicago, Ill.		
D. G. Musser, Wellsville, O.		
H. H. Pollock, Carnegie, Pa.		
J. Wallenfelsz, Cambridge, O.		
D. C. Zook, Fort Wayne, Ind.		
Pennsylvania R. R.	5	5,304
M. M. Barton, West Philadelphia, Pa.		
Richard G. Develin, Philadelphia, Pa.		
H. R. Leonard, Philadelphia, Pa.		
Robert McKibbon, Altoona, Pa.		
C. W. Richey, Pittsburg, Pa.		
Pere Marquette R. R.	7	2,336
J. D. Black, Saginaw, Mich.		
Edw. Guild, Edmore, Mich.		
G. E. Hanks, East Saginaw, Mich.		
A. McNab, Holland, Mich.		
John Robinson, Grand Rapids, Mich.		
J. E. Toohey, Grand Rapids, Mich.		
J. P. Wood, Edmore, Mich.		

Name of Road and Membership.	Members.	Mileage
Philadelphia & Reading Ry.	4	1,481
Amos H. Beard, Reading, Pa.		
John Foreman (retired), Pottstown, Pa.		
E. G. Storck, Philadelphia, Pa.		
E. E. Templin, Pottsville, Pa.		
Pittsburg & Lake Erie R. R.	2	215
D. L. McKee, McKee's Rocks, Pa.		
G. H. Soles, Pittsburg, Pa.		
Queen & Crescent Route	1	509
E. L. Loftin, Vicksburg, Miss.		
Quincy, Omaha & Kansas City R. R.	1	261
T. F. DeCapito, Milan, Mo.		
San Pedro Los Angeles & Salt Lake R. R.	4	1,075
F. M. Bigelow, Salt Lake City, Utah.		
R. R. Bishop, Salt Lake City.		
W. C. Frazier, Los Angeles, Cal.		
D. W. Scannell, Salt Lake City.		
Seaboard Air Line Ry.	8	3,046
W. M. Barker, Scotia, S. C.		
B. B. Christy, Tallahassee, Fla.		
W. J. Gooding, Jr., Savannah, Ga.		
B. Land, Jr., Jacksonville, Fla.		
W. A. McDearmid, Tallahassee, Fla.		
J. C. Nelson, Portsmouth, Va.		
G. B. Smith, Jacksonville, Fla.		
J. L. Winter, Waldo, Fla.		
St. Joseph & Grand Island Ry.	2	319
O. H. Andrews, St. Joseph, Mo.		
Wm. Carmichael, St. Joseph, Mo.		
St. Louis & San Francisco R. R.	1	4,740
F. G. Jonah, St. Louis.		
St. Louis, Rocky Mt. & Pac. R. R.	1	106
Alf Brown, Raton, N. M.		
St. Louis Southwestern Ry.	2	1,451
J. S. Berry, St. Louis, Mo.		
Wm. Quinn, Tyler, Tex.		
Southern Ry.	14	7,090
D. A. Ballenger, Greenville, S. C.		
J. H. Blackwell, Charleston, S. C.		
H. S. Douglass, Charleston, S. C.		
W. F. Fraylick, Charleston, S. C.		
J. R. Fowlkes, Columbia, S. C.		
N. L. Hall, Greensboro, N. C.		
Joseph A. Killian, Jr., Charlotte, N. C.		
J. S. Lemond, Charlotte, N. C.		
J. W. Morgan, Columbia, S. C.		
C. A. Redinger, Charlotte, N. C.		
T. E. Sharpe, Greenville, S. C.		
J. B. Teaford, Lawrenceburg, Ky.		
G. W. Welker, Alexandria, Va.		
A. A. Wells, Winston-Salem, N. C.		

Name of Road and Membership	Members.	Mileage
Southern Pacific Company,	54	6,663
C. J. Astrue, Oakland Pier, Cal.		
T. W. Bratten, West Oakland, Cal.		
H. Bulger, Oakland Pier, Cal.		
W. H. Burgess, Stockton, Cal.		
D. Burke, Tucson, Ariz.		
W. E. Burns, Portland, Ore.		
J. T. Caldwell, Bakersfield, Cal.		
W. S. Corbin, Los Angeles, Cal.		
G. S. Crites, Los Angeles, Cal.		
D. M. Crosman, Los Angles, Cal.		
L. V. Degnan, Oakland Pier, Cal.		
Geo. Dickson, Oakland, Cal.		
R. M. Drake, San Francisco.		
B. F. Ferris, Los Angeles, Cal.		
J. F. Fisher, Sacramento, Cal.		
M. Fisher, Ogden, Utah.		
A. Fraser, Bakersfield, Cal.		
Neil Fraser, Salem, Ore.		
P. Fritz, Los Angeles.		
Ira Gentis, Oakland, Cal.		
J. A. Givens, Sacramento, Cal.		
Jas. Gratto, Los Angeles, Cal.		
C. F. Green, Sacramento, Cal.		
P. Guisto, San Francisco.		
W. C. Harmon, Bakersfield, Cal.		
J. Hubley, Colfax, Cal.		
C. A. Jensen, Los Angeles.		
A. W. Lasher, Suisun, Cal.		
T. J. Linehan, Ventura, Cal.		
H. Lodge, San Francisco.		
J. B. Malloy, San Francisco.		
J. D. Mathews, Tucson, Ariz.		
F. D. Mattos, W. Oakland, Cal.		
M. J. Mayer, San Francisco, Cal.		
C. W. McCandless, Ventura, Cal.		
D. McGee, Sacramento, Cal.		
A. M. McLeod, Oakland, Cal.		
E. C. Morrison, San Francisco.		
J. J. Murphy, Oakland, Cal.		
P. N. Nelson, San Francisco, Cal.		
Harry Pollard, San Francisco, Cal.		
Homer Pollard, West Oakland, Cal.		
Geo. W. Rear, San Francisco, Cal.		
Norman Rose, Portland, Ore.		
W. M. Rose, Sacramento, Cal.		
J. S. Replogle, Oakland, Cal.		
D. T. Rintoul, Bakersfield, Cal.		
A. L. Robinson, Stockton, Cal.		
Niles Searls, San Francisco, Cal.		
F. M. Siefer, Portland, Ore.		
E. T. Vincent, Los Angeles.		
A. Weldon, Bakersfield, Cal.		
I. G. Wiley, Dunsmuir, Cal.		
M. M. Wilson, Los Angeles, Cal.		
Tennessee, Alabama & Georgia R. R.	1	98
C. H. Fisk, Chattanooga, Tenn.		
Texas & Pacific Ry.	1	1,885
E. Loughery, Marshall, Tex.		

Name of Road and Membership.	Members.	Mileage
Texas Midland R. R.	1	125
E. H. R. Green, Terrell, Tex.		
Toledo, Peoria & Western Ry.	1	248
J. H. Markley, Peoria, Ill.		
Toledo Railways & Light Co.,	1	110
A. Swartz, Toledo, O.		
Union Pacific R. R.,	1	3,574
J. Parks, Denver, Colo.		
Vandalia R. R.	1	829
J. L. McKee, Spencer, Ind.		
Virginian Ry.,	1	444
P. W. Cahill, Roanoke, Va.		
Wabash R. R.	2	2,514
A. O. Cunningham, St. Louis, Mo.		
William S. Danes, Peru, Ind.		
Washington Terminal Co.	2	53
W. M. Cardwell, Washington, D. C.		
C. H. Spencer, Washington, D. C.		
Wellington & Manawata Ry. (New Zealand)	1	84
Arthur Williams, Wellington, New Zealand.		
Western Australia Government Rys.	2	1,943
W. J. George, Perth, Western Australia.		
E. S. Hume, Midland Jct., Western Australia.		
Western Pacific Ry.	3	934
T. J. Stuart, Elko, Nev.		
M. R. Krutsinger, Sacramento, Cal.		
Norton Ware, San Francisco.		
Wheeling & Lake Erie R. R.	2	496
Wm. Mahan, Canton, O.		
W. L. Rohbock, Cleveland, O.		
Yazoo & Miss. Valley R. R.	2	1,370
D. H. Holdridge, Vicksburg, Miss.		
Total Members and Mileage,	470	231,967
Members not with Railroads,	54	
Total Membership,	524	

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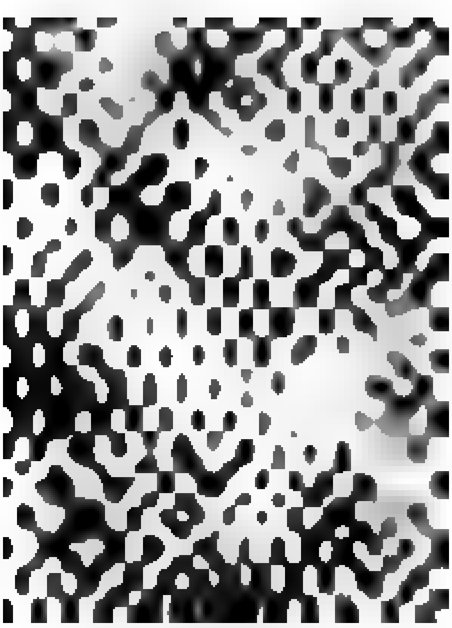

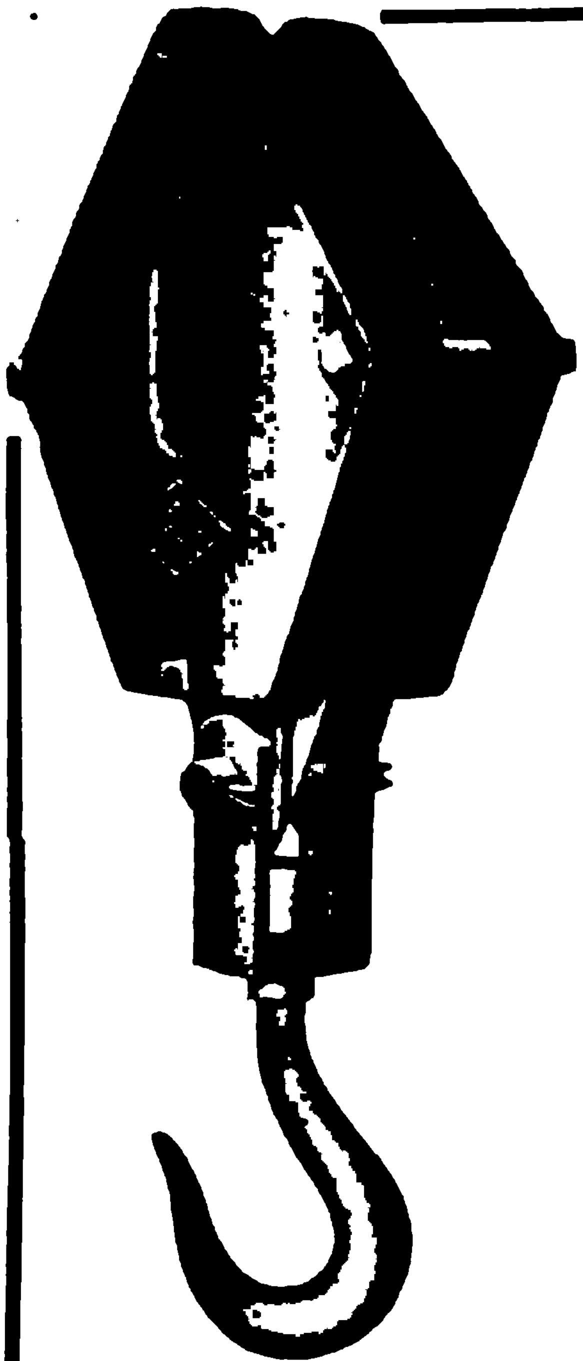

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Editor Railway and Engineering Review

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